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SEPTEMBER 5, 1960

missiles and rockets

HE MISSILE/SPACE WEEKLY

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Linde's New Liquid Hydrogen Plant

SPECIAL REPORT ON TITAN 1

Exclusive Details of Terne ASW Bird . 42

AN AMERICAN AVIATION PUBLICATION

LIBRASCOPE COMPUTER FACILITIES

Shown below is a composite view of Librascope's facilities where a variety of computer systems are currently in different stages of design and production. Some are strategically involved with national defense...others deal with business and industrial process control. Each is uniquely designed to answer a particular need. The success of these systems illustrates the value of Librascope's engineering philosophy: A decentralized organization of specialized project teams responsible for assignments from concept to delivery...and backed up by excellent research, service, and production facilities. For your computer requirements, call on the company whose breadth of diversification in computer technology is unsurpassed. ■ Librascope Division, General Precision, Inc., 808 Western Avenue, Glendale, Calif. For career opportunities write to John Schmidt, Engineering Employment. ■

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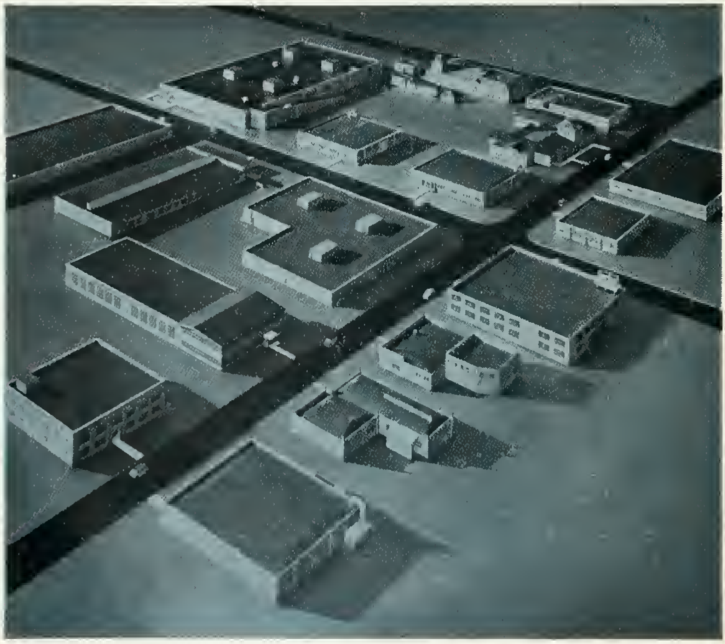

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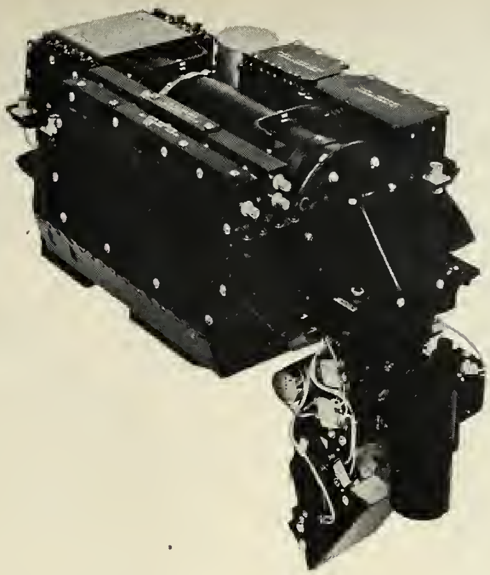

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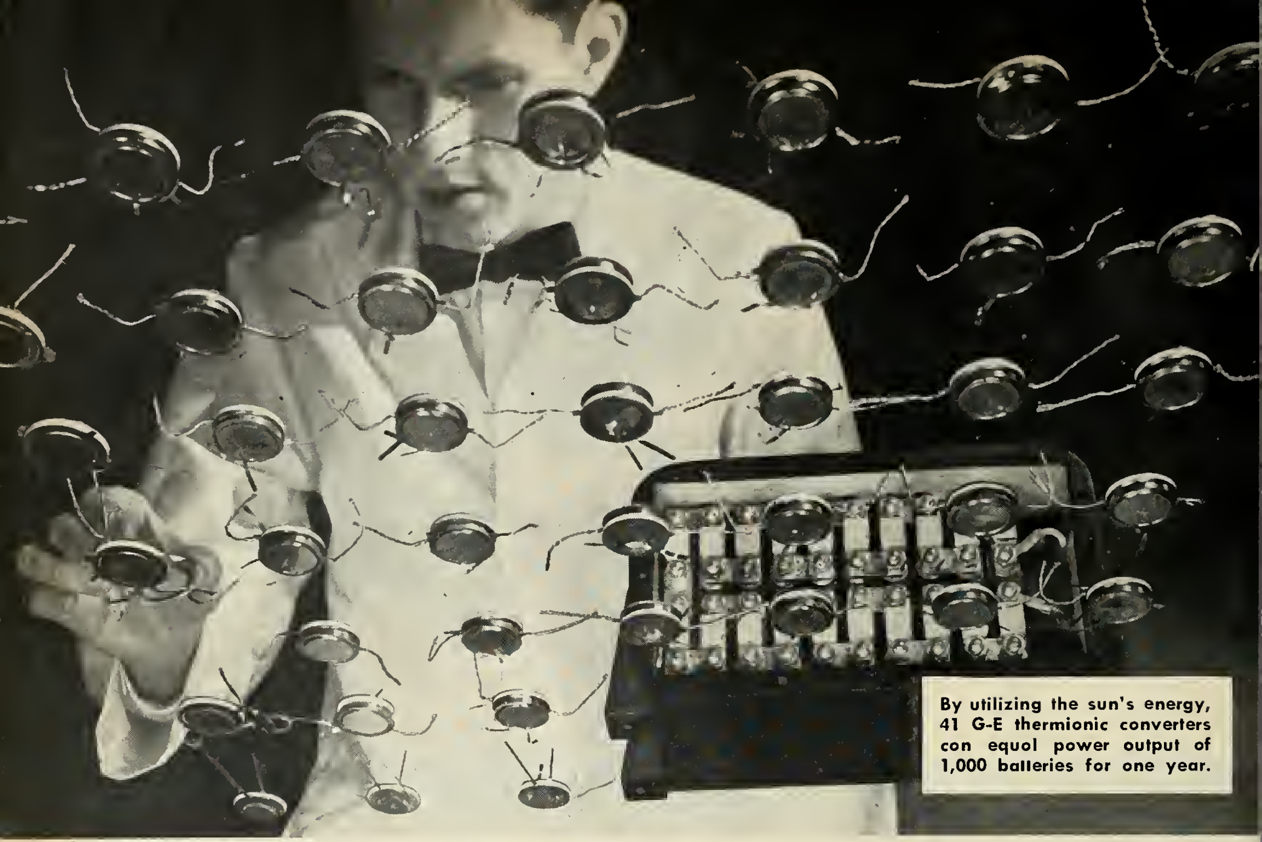

By utilizing the sun's energy, 41 G-E thermionic converters can equal power output of 1,000 batteries for one year.

MISSILE AND SPACE VEHICLE DEPARTMENT | *...center for missile and space technology research and development at General Electric*

Progress in power for space

Manned space flights, as well as other U.S. space projects, will require new, light-weight, long-life sources of electrical energy. Conventional batteries, now being used in missiles and satellites, are far too heavy for most future space applications.

For example, during a year's operation, one thousand 15 amp/hr batteries, similar to the one shown above, would be required to equal the 41 watts which the thermionic converters in the photo can generate from the heat of the sun. These batteries would weigh 15,000 lbs—a complete thermionic system, including the converters developed in General Electric's Research Laboratory plus a collector and orientation equipment, only about 20 lbs.

To provide such new, light-weight systems, engineers at General Electric's Missile and Space Vehicle Department are investigating a wide variety of promising space power sources, utilizing the specialized capabilities of other Company research operations. For instance, under U.S. Air Force contract, G.E. is conducting extensive research in thermionics, and is developing an experimental thermionic system consisting of a solar collector, converters, and storage and control components. Intensive work in photovoltaics includes the development of an advanced unit to provide more than 500 watts of continuous power for the Advent communications satellite.

For the U.S. Army Signal Research and Development Laboratory, a regenerative fuel cell is under development, as are magnetohydrodynamic electrical converters for the Air Force Office of Scientific Research, WADD and BMD. In addition, MSVD is investigating nuclear thermionics and nuclear turbines.

To learn more about these MSVD space power developments, write to Section 160-76, General Electric Co., Missile and Space Vehicle Department, Philadelphia 1, Penna.

160-76

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MISSILE AND SPACE VEHICLE DEPARTMENT

A Department of the Defense Electronics Division

Scientists and Engineers interested in career opportunities in Space Technology, contact Mr. T. H. Sebring, Dept. 160, MSVD

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THE MISSILE/SPACE WEEKLY

missiles and rockets

September 5, 1960 Volume 7, No. 10

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An American Aviation Publication

THE COVER

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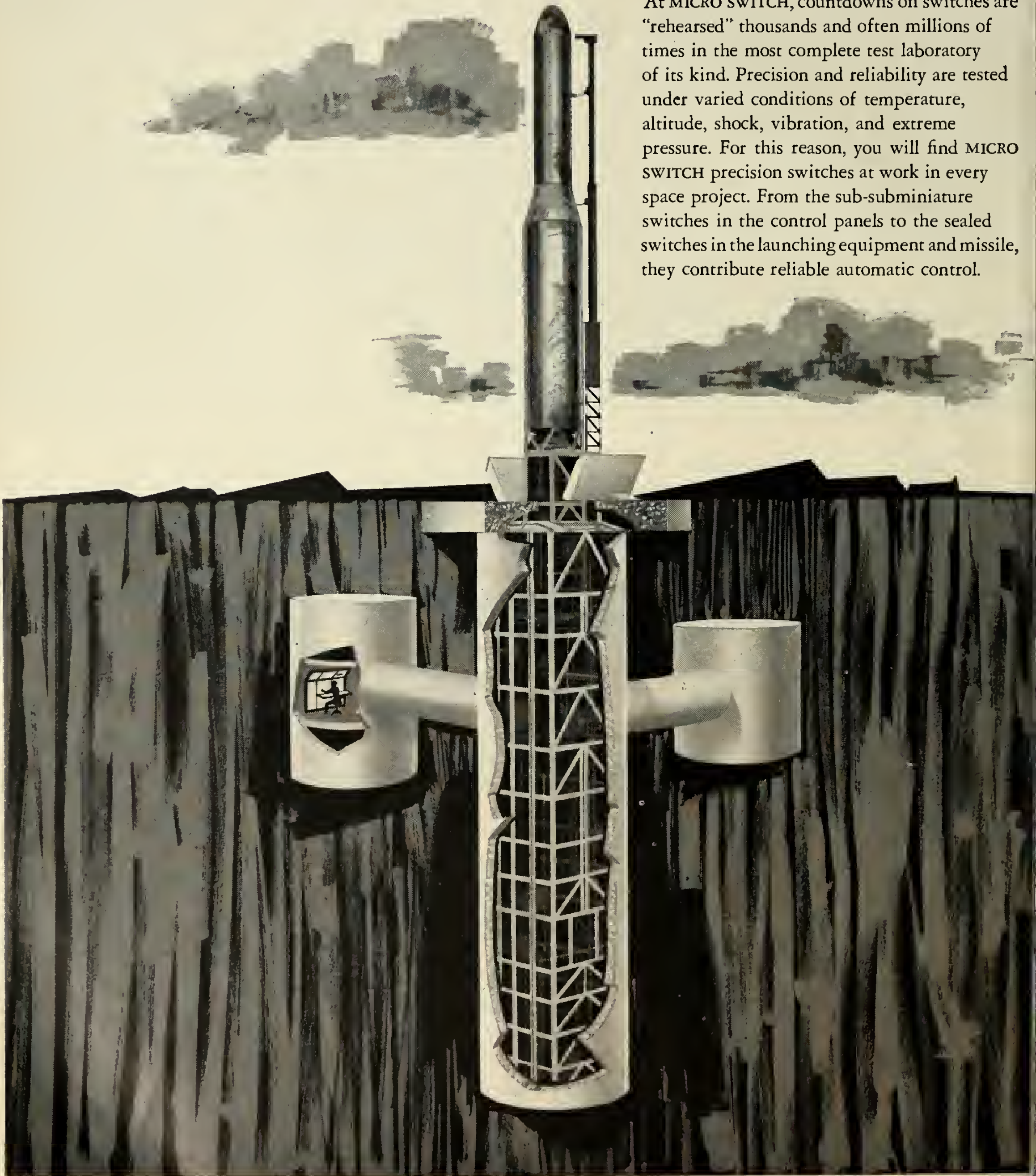

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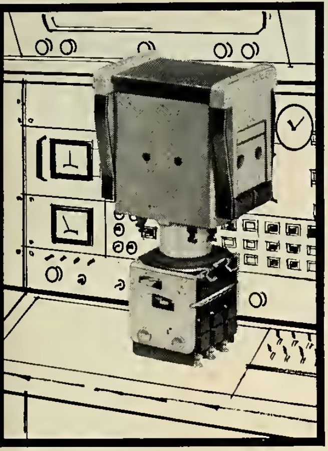
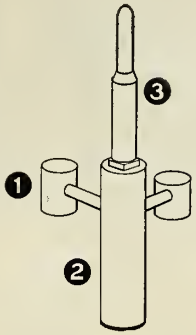
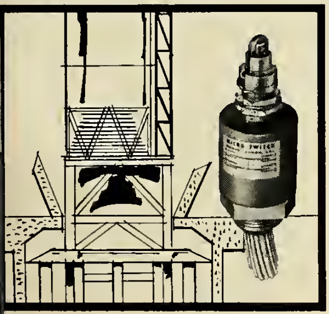




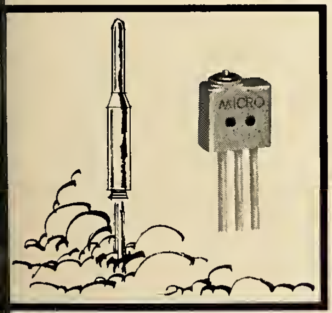
① GROUND SUPPORT CONTROL

MICRO SWITCH "Series 2" Lighted Push-Button Switches meet the very latest requirements in the field of Human Engineering. Their modular design permits complete flexibility in the arrangement of visual indicators on the control panel. Behind the panel they can be connected to an infinite number of switch combinations. "Series 2" switch modules simply snap together to fit your design requirements, then snap into slots in the mounting panel—all without tools. Write for Catalog 67.



② LAUNCHING

MICRO SWITCH "EN" Series and "HR" Series switches perform automatic control and signal functions during launching. They are sealed against the elements, making them completely reliable on outside gantry locations. Their shock-resistant design makes them suitable for use in explosion areas. They can be adapted to many different applications through their wide selection of actuators. Write for Catalog 77.



③ MISSILES

The new Sub-subminiature "XE" Switch is an environment-sealed switch, yet is smaller than a dime. It was developed by MICRO SWITCH to make possible a 30% savings in size and a 20% savings in weight over any previous environment-sealed snap-action switch, while still maintaining the same electrical rating. The "XE" is typical of new switches for missiles and advanced aircraft applications that give MICRO SWITCH unmatched experience. Write for Data Sheet 169 on the "XE" or Catalog 78 which describes many other sealed switches for these applications.

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December, 1958: Project SCORE. AED developed the communications and control systems for the U.S. Army Signal Corps' "Talking Atlas", part of a program under ARPA, Dept. of Defense. Transmitters, receivers and control units in the satellite and at the ground stations all operated perfectly as the "Talking Atlas" broadcast the President's Christmas message and proved the feasibility of active communications satellites.

April, 1960: TIROS I. The sophisticated satellite, including its structural design as well as the electronic systems, and its ground stations were developed and built for NASA by AED under the technical direction of the U.S. Army Signal Corps. It accomplished its mission in meteorological observation, sending down over 20,000 TV pictures of earth and its cloud cover.

August, 1960: Project ECHO. The only electronic equipment on this 100-foot balloon, launched by NASA to prove the feasibility of passive communications satellites, are two "dinner plate" beacon transmitters 10 inches across by ⅜ inch thick, including storage batteries and solar cells. These units, designed to permit beacon tracking of the satellite, weigh only 11 ounces apiece and were developed and built by AED.

As more and more sophisticated space systems are developed, AED will continue to design for reliability in this most demanding of all environments. To find out how you can draw on this dependable R&D capability, contact the Manager, Marketing, RCA Astro-Electronics Division. If you are interested in participating in this challenging team effort, contact the Employment Manager, Astro-Electronics Division, Defense Electronics Products, at RCA's "Space Center" in Princeton, N. J.

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The Countdown

WASHINGTON

Red Missile Photographed

Extremely clear color photos of a Russian missile warhead which blazed into the Pacific July 7 are in the possession of the U.S. COUNTDOWN has learned the pictures—taken from U.S. aircraft—are so plain they have enabled intelligence experts to identify the type of ablating material used on the re-entry vehicle. Just what type has been classified by the Pentagon, along with the pictures. The missile was the second in a test series of two rockets fired by the Russians more than 8000 miles, presumably from a base near Murmansk.

TBX is Killed

The Air Force top command, COUNTDOWN is told, has flatly rejected Tactical Air Command proposals for developing the so-called TBX—a tactical-range ballistic missile. The weapon—suggested as a 1000-mile-range missile for NATO—is considered unnecessary. This leaves TAC without a successor to the fighter-bomber in the late '60's.

Norstad Leaving Soon?

Talk persists that Gen. Lauris Norstad will step down fairly soon as commander of NATO and retire from the Air Force. The reason: there appears to be no job for him to go to. Gen. Thomas White, AF chief of staff, continues to be considered the top condidate to succeed Norstad.

Atlas Base Increase

A possible increase in the present 13 *Atlas* squadrons is understood to be up for decision at the Secretary of Defense level. The Air Force wants two more 12-missile squadrons (dispersed in silos in a 12-by-1 configuration) and is gaining some support for the idea.

Picking Last Titan Site

The site for the last of the planned 14 *Titan* squadrons is all but set. The location is expected to be announced by the AF within two months.

Another Courier Try Coming Up

Next attempt at launching the first *Courier* Signal Corps communications satellite may come within a few weeks. The first try failed Aug. 18 when the *Thor-Able-Star* booster blew up.

On the Pad

NASA's *Atlas-Able* Moon orbiter is on the pad for launching late this month, probably between Sept. 25 and Sept. 29 when the moon is at perigee . . . But the first flight of the polar-orbiting second-generation *Nimbus* weather satellite now has slipped to the first half of 1962. It was to go in late '61.

INDUSTRY

Demand Drops for Engineers, Scientists

An index based upon recruitment advertising shows that the demand for engineers and scientists throughout industry fell 13% in July. Deutsch & Shea Inc., which developed the index, says the drop-off continues a downward trend established in the second quarter of 1960 and is partly explained by a seasonal slack in recruiting.

Army Spending $1.3 Billion on Rockets

FY 1961 spending on missiles by the Army is now computed at $1.3 billion. The Army says 10% of this figure is being spent in-house and the remainder is going to industry.

New Saturn Static Tests

A new series of *Saturn* static tests using the prototype SAT booster (modified as the result of tests this spring) will begin late this month or early next at Huntsville. Construction is continuing meantime on *Saturn-1*, which will be launched in its first flight test from the Cape next year.

Name Changes

The Crosley Division of Avco Corp. is being renamed the Avco Electronics and Ordnance Division (reflecting the company's switch from consumer production) . . . International Telephone and Telegraph Corp. is shortening the name of its communications division—Kellogg Switchboard and Supply Co.—to simply ITT Kellogg . . .

INTERNATIONAL

Italy Starts IRBM Project

SISPRE is prime for a mobile 900-mile missile being started by Italy's Ministero Difensa Aeronautica. The weapon could be used to cover targets from the Balkans to Warsaw.

French A-bomb Testing

France is reported preparing to explode an atomic weapon underground in north Africa north of Tamanrasset in the Hogar Mountains. The shot could come as early as Oct. 15.

British Firm Expanding

COUNTDOWN hears Cossor Communications Co. Ltd. is branching out into the missile guidance and GSE field. Well known in radar, Cossor has hired top missilemen from the guided weapons department of the R.A.E. and from Ferranti Ltd.

Big Red Missile Buy

Word from under the Iron Curtain has Khrushchev ordering into production 100,000 of Russia's new *M-55* tactical missile. The missiles reportedly require the diversion of 2 billion rubles.

TITAN

SPECIAL REPORT

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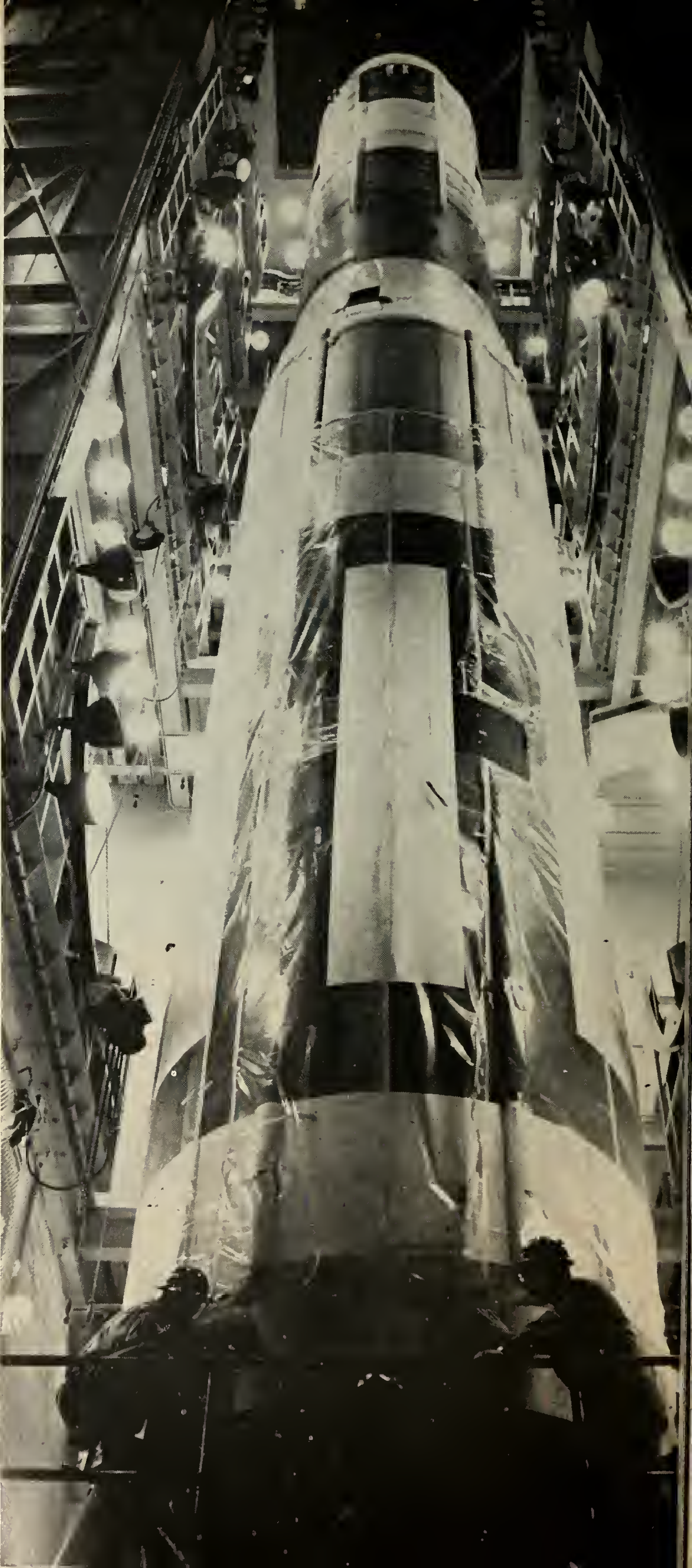


PRIOR TO static firing, Titan is tested in Martin-Denver's Vertical Test Lab.

SAC Getting ICBM 'Crusher'

Massive $4.9-billion program will provide vehicles for multi-megaton nuclear warheads—and powerful boosters for Air Force space projects; more than 230 will be built

by James Baar

CRUSHING nuclear power and military space work are clearly emerging as the *Titan* program's top goals as it drives toward its first technically operational launching by Jan. 1.

Titan II will provide SAC with a missile capable of delivering the largest nuclear warhead in the nation's ICBM arsenal—possibly well over 10 megatons.

The huge Martin ICBM, powered by fast-reaction storable fuel, will be SAC's main assault missile for obliterating the enemy's hardened targets.

Titan I and, later, *Titan II* will provide the Air Force with boosters capable of hurling *Dyna-Soars* and other space vehicles and satellites into orbits around the earth and into lunar space.

They will be, in the language of their manufacturer, military "space trucks" of the future.

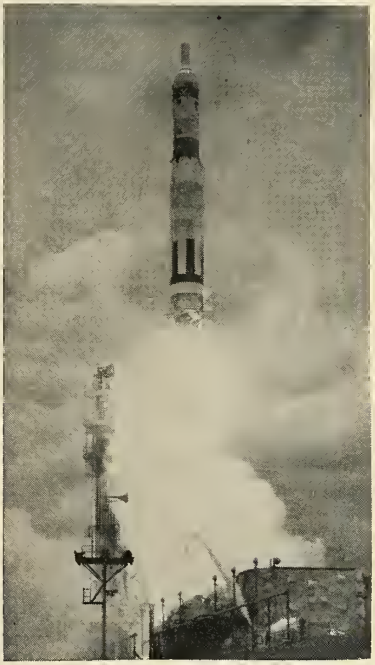
• **SAC crew shot**—The *Titan* program's timetable now looks approximately like this:

–The first V series *Titan* is scheduled to be launched from a test silo at Vandenberg AFB, Calif., within the next eight weeks. The "V birds" are similar to the instrumented all-but-operational J series *Titans* that have been launched from surface pads at Cape Canaveral.

–The first technically operational *Titan I* is scheduled to be launched by a SAC crew 30 to 60 days later from the three-silo *Titan* training site at Vandenberg. The SAC crew later will be part of the cadre of *Titan* instructors.

–The first full nine-missile *Titan I* squadron is scheduled to be operational at the sites surrounding Lowry AFB, Colo., in the fall of next year. Six are slated to be operational by early 1963.

–The first *Titan II* R&D missile is scheduled to be launched from Cape Canaveral in late 1961. The first of eight *Titan II* squadrons is scheduled to be operational by early 1963.



A TITAN I ICBM takes off from launch pad at AFMTC, Cape Canaveral.

The Air Force says the *Titan* program has recovered time lost last year and this year when R&D difficulties resulted in three blow-ups and other snags at Cape Canaveral.

Moreover, Col. Albert J. Wetzel, *Titan* program director at the Air Force's Ballistic Missile Division, has said: "There are no major basic technical problems outstanding in the *Titan I* program."

• **To build 230 birds**—The present official Air Force score on *Titan* R&D shots, including the successful launching of a "J" series bird from Cape Canaveral Aug. 30, is: 14 successes, two partials, and five failures.

Some 50 more R&D shots are scheduled—about evenly divided between *Titan I's* and *Titan II's*. That would bring the total R&D launchings to about 70.

The total *Titan I* and *Titan II* production run now planned is about 230, exclusive of *Titan* production for space work.

The main R&D effort in the *Titan* program is rapidly swinging to *Titan II*.

The division of the program into two distinct missiles is a sharp break with the step-by-step manner in which *Atlas* was developed.

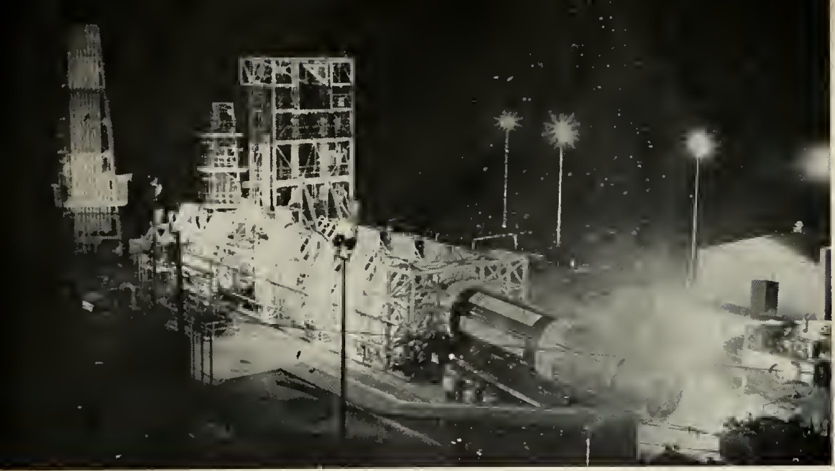
Because of the pressure on the *Atlas* program, improvements generally were introduced into the production line as quickly as possible. This was not done with *Titan*. Instead, a cut-off point was established for the introduction of further modifications into *Titan I*, and these were collected for introduction into *Titan II*.

The result is that *Titan II* is for all practical purposes a second-generation missile.

Like the solid-propelled *Minuteman*, the Air Force's main second-generation ICBM, it will have a reaction time of one minute rather than the 15 minutes of *Atlas* and *Titan I*. Like *Minuteman*, it will have higher reliability because of its relative simplicity. Like *Minuteman* and the *Atlas* "E" series, it will have all-inertial guidance.

Titan II will not have *Minuteman's* mobility or relatively low cost. But it will provide a means of delivering a far greater warhead.

• **$4.9 billion program**—The first *Atlas* squadrons are manning each



TITAN'S FIRST STAGE is removed from the erector following a static firing at the Denver Division of The Martin Co.

complex of three missiles with 16-man crews. The first *Titan I* squadrons are expected to man each complex of three missiles with 10-man crews.

Each dispersed *Titan II* is expected to be manned by a two- or three-man crew. Each group of 10 dispersed and unmanned *Minutemen* is expected to be launched remotely by a two-man crew.

Air Force figures on the cost of *Titan* bases vary, depending on whether development costs are included.

Official Air Force estimates put the total cost of the *Titan* program at $4.9 billion—about $2.7 billion of which is to be spent by the end of FY 1961. On the basis of the presently planned 14 squadrons, the average cost per squadron of nine ready-to-launch missiles is $350 million.

However, excluding the development costs, the Air Force puts the cost of each *Titan I* squadron at $166.5 million and each *Titan II* squadron at $138 million.

Comparatively, the Air Force has estimated the cost of the early soft *Atlas* squadrons at $133 million and the improved, hardened *Atlas* squadrons at $152 million. The *Atlas* figures also do not include development costs.

One of the principal reasons for the decrease in the cost of the *Titan II* squadrons and the increase in the cost of the later *Atlas* squadrons is that one can be stripped of much support equipment while the other calls for more such equipment.

• **No strategic overlap**—*Minuteman* is expected to be far cheaper than either *Atlas* or *Titan*.

Estimates of *Minuteman* costs also vary considerably. However, many Air Force officials expect the total *Minuteman* program to cost not more than $2 billion, including development. This would pay for some 450 *Minutemen* scattered in silos across the country and some 150 *Minutemen* deployed on 50 missile trains.

The first fixed *Minuteman* squadrons are scheduled to become operational in the second half of 1962; the first train squadrons in 1963. Thus the *Minuteman* and *Titan II* programs overlap—but not strategically.

Only *Titan II* among the nation's big strategic missiles will have the striking power to knock out a hardened target without expending large numbers to ensure success.

For example, assume the target is a Soviet missile site hardened to withstand pressures of 100 lbs. per square inch. Also assume the missile to be launched against it has a one-megaton warhead and a CEP of about two miles.

In order to have a 90% chance of destroying the missile site, about 19 missiles would have to be launched against it.

On the other hand, a 10-megaton ICBM with the same CEP greatly reduces the number needed. About six missiles could do the job of the 19.

• **Super destruction**—If accuracy improves and the CEP can be reduced to 1.5 miles, about 14 one-megaton missiles would be needed—still a large number. But two 10-megaton missiles could do the job—and more.

The reason for this, of course, is the immensity of a 10-megaton blast. Such a warhead detonated on the surface could dig a crater 250 feet deep and a half-mile across. The fireball would be more than two miles wide.

Both *Atlas* and *Titan I* are considered to be capable of carrying multi-megaton warheads. But *Titan II* alone is considered to be in the super warhead class.

Titan's space role is equally formidable.

At present, all Air Force plans for the use of *Titan* as a space booster are officially centered on the *Dyna-Soar* R&D program. However, the potentialities of both *Titan I* and *Titan II* for space work are considered to range far beyond *Dyna-Soar*.

Martin officials have said that *Titan I* in its present form is capable of launching a 2.5-ton satellite into orbit around the earth, and that a modified *Titan I* would be capable of launching more than a five-ton satellite.

• **Booster for space ships**—Dr. Albert C. Hall, Martin vice president for engineering, has said that *Titan I* without new development could launch a major space vehicle around the moon or place a small instrumented payload on the moon.

Titan II is considered capable of launching manned spacecraft on missions in lunar space.

Initially, Air Force plans call for using only *Titan I* in the *Dyna-Soar* program. However, *Titan II* is expected to be brought into the program as it advances toward development of operational military spacecraft.

At the same time, some experts close to the *Titan* program foresee the use of *Titans* to launch military missile defense satellites and other types of military space stations.

This is *Titan*—in war and space.

Planned Deployment of Titan ICBM's

Base Location	Number of Squadrons*	Base Configuration
Lowry AFB, Denver	2	3 missiles at each of six sites
Ellsworth AFB, S.D.	1	3 missiles at each of three sites
Beale AFB, Calif.	1	3 missiles at each of three sites
Larson AFB, Wash.	1	3 missiles at each of three sites
Mountain Home AFB, Idaho	1	3 missiles at each of three sites
Davis-Monthan AFB, Ariz.	2	18 missiles at 18 sites
McConnell AFB, Kans.	2	18 missiles at 18 sites
Little Rock AFB, Ark.	2	18 missiles at 18 sites
Undesignated	2	18 missiles at 18 sites

Total Bases: 9; Total squadrons: 14; Total launchers: 126.

**Each squadron has 9 Titans and launchers plus one spare Titan.*

As Red manned shot looms . . .

Administration Acts to Speed Apollo

by Jay Holmes

Under pressure of a possible pre-election man-in-space shot by Russia, the Eisenhower Administration is prodding into life NASA's Project *Apollo* —the plan for a three-man space ship.

Until last week what one congressman called merely a "designers dream," *Apollo* now has been raised to full study status, with plans to move it swiftly into the R&D stage.

NASA has set up a timetable to complete study contracts by the middle of next May. It also plans to ask for R&D money in the FY 1962 budget.

The timetable was given to industry at an Aug. 30. conference in Washington by Robert R. Gilruth, director of NASA's Space Task Group. He set Sept. 6 as the deadline for expression of interest by prospective bidders, with a bidders conference to be held Sept. 12 at the Langley, Va., NASA Research Center. Proposals are due Oct. 10, with contracts (probably more than two) to be awarded Nov. 14.

Tentative plans call for design, development and manufacture of the space ship, which would be boosted by a *Saturn* launching vehicle, in 1962-65. Active flight testing and mission flights are projected for 1965-70.

Apollo will carry provisions and atmosphere for flights lasting several weeks. It is to come down on dry land, but must be designed for emergency landings on land or water, and able to sustain the crew for several days after landing.

- **Space station step**—Command of the mission will be on board the space ship, with almost continuous contact with the earth. The crew will be expected to fulfill a role comparable with that of a transcontinental jet airliner.

Gilruth listed some of the major technological problems as:

–Coping with or avoiding excessive solar radiation.

–Safe crew recovery in case of space ship or booster malfunction.

–Managing heat and other loads resulting from re-entry into the atmosphere at speeds near 36,000 ft./sec.

Apollo's multimission capability, Gilruth said, will include a variety of scientific, technological and civilian services as an earth-orbiting vehicle. It will serve also as an intermediate step toward the establishment of manned space stations.

When later versions of the *Saturn* vehicle are available, *Apollo* will be capable of manned reconnaissance flights to the vicinity of the moon.

- **Launch program**—John W. Townsend Jr., assistant director of the Goddard center, gave details of satellites to be launched soon.

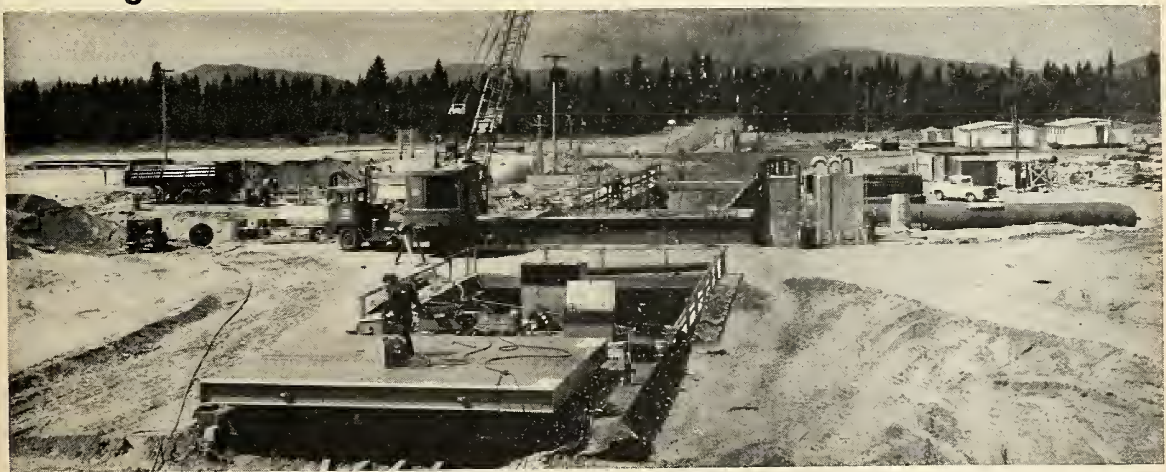
The *Juno II* satellites—following Explorer VII, S-15 and S-45, both built by the Marshall Space Flight Center, will be launched in the next six to eight months. S-15 will study gamma rays and S-45 will be a multifrequency ionosphere beacon.

Typical missions of the Goddard center, Townsend said, are the ionospheric topside sounders, S-48 and S-27. American industry is building S-48 while Canada is producing S-27 as part of the international cooperation program. Other Goddard satellites include S-30, an ionosphere direct measurements satellite; S-51, the United Kingdom satellite; S-16, the orbiting solar observatory; S-6, the atmospheric structures satellite; P-14, the magnetometer probe; and P-26, the nuclear emulsion recovery vehicle (NERV).

Robert J. Mackey, head of the Communications branch, reported that NASA is interested in active communications satellites. Although NASA has no active program in this area, he said, Department of Defense activities are being monitored and studied to determine their implication to civilian communication studies.

The Orbiting Geophysical Observatory, project manager Wilfred E. Scull said, will be used on two separate missions. The Polar Orbiting Geophysical Observatory (POGO) will be used on low-altitude polar orbits for study of the atmosphere and ionosphere. The Elliptical Geophysical Observatory (EGO) will follow highly elliptical, low-altitude orbits to study energetic particles and magnetic fields.

Building semi-hard Atlas Pads



FIRST 'HOLLYWOOD HARD' Atlas pads are taking shape at Sheppard Air Force Base near Wichita Falls, Tex. Being constructed flush with the surface of the surrounding ground, the pads are an intermediate step toward fully hardened silo launchers.

The Missile/Space Week

Reds May Have Dyna-Soar Type Vehicle

Information obtained by U.S. scientists is reported to indicate that the Soviet "space menagerie" satellite may have been a winged *Dyna-Soar* type spacecraft. Until now it has been generally assumed that the Russians brought their two dogs back to earth from orbit Aug. 20 in a *Mercury*-type capsule rather than a more advanced vehicle.

Use of a winged spacecraft, if it could be controlled from the ground, would explain how the Russians were able to obtain a high degree of accuracy in returning the life capsule. European military sources have reported previously that the Russians were working on the *Dyna-Soar* type T-4A, reported to weigh about 3000 lbs. The Soviets said the space menagerie weighed nearly 5 tons.

NASA Wins Rover Control

The National Aeronautics and Space Administration has won a five-month struggle with the Atomic Energy Commission for control of the project *Rover* nuclear rocket. Harold B. Finger, NASA chief of nuclear propulsion, was chosen to head a joint NASA-AEC Nuclear Propulsion Office (NPO), set up at AEC headquarters in Germantown, Md. Milton Klein, assistant manager for technical operations in the AEC's Chicago Operations Office, will be Finger's deputy.

The joint NASA-AEC announcement said the new offices will be staffed by employees drawn from both agencies. However, it will not include Col. Jack E. Armstrong, who has headed the AEC effort as deputy chief of the Aircraft Nuclear Propulsion Office. Finger said he would have a staff of about 10 or possibly a few more, planned to set up operations in Germantown late last week. He said he will be in charge of Project *Rover,* with authority to make decisions that formerly had to be made by agreement between NASA and AEC.

Echo's Reflectivity Holds Up

So far, radio reflections from the *Echo I* balloon satellite have suffered no permanent ill effect from passing through the earth's shadow. A slight distortion of signals was observed on passes through the shadow during the first eight days beginning Aug. 23, but the quality returned when *Echo* reentered sunlight. This would indicate that sufficient gas remains in the balloon to reinflate it each time it returns. By Aug. 30, *Echo* was spending 27 minutes of each 118-minute orbit in darkness. This is expected to increase to about 37 minutes by late November and then gradually decrease to zero in another three months.

SBA 'Dictator' Bill Fought

Congressional leaders are expected to block a rider which could give the Small Business Administrator virtual dictatorial power on DOD procurement contracts. The controversial measure, S3903, is an amendment to the Small Business Act proposed by Sen. William Proxmire (D-Wis.) Legislative authorities, including House Armed Services Committee Chairman Carl Vinson (D-Ga.), say it would hand the SBA Administrator power to make defense contracts conform to his judgement in small business subcontract set-asides. It would also enable him to obtain contractors' records from government procurement agencies—a "search warrant" as some have termed it.

ICBM Base Catch-up Seen by February

Industry officials in the *Atlas* base contruction program are optimistic about the new AF management set-up (M/R, Aug. 22, p. 8) to end slippage. Some are hopeful of getting back on the original schedule by January or February. Last week, the AF handed over to SAC the remaining three pads of the 564th Strategic Missile Squadron at Warren AFB, Cheyenne, Wyo. The 6-pad squadron is now the nation's first fully operational combat ICBM unit.

Linde's Liquid Hydrogen Plant on Regular Delivery

Linde Co. reports distribution is now on a regular delivery schedule from its new liquid hydrogen plant in Torrance, Calif., which has a capacity of 13,000 lbs. a day. (See cover)

The plant, which went on stream June 27, has shipped more than 300,000 lbs. of the supercold liquid to West Coast missile/space development projects. It is the first privately owned and operated facility to supply liquid hydrogen on a commercial basis. Linde designed and constructed the plant after winning a contract in April, 1959, to sell up to 3,300,000 lbs. a year to the National Aeronautics and Space Administration.

The NASA contract was awarded on the basis of an estimated maximum requirement of 10,000 lbs. a day. However, this need will grow rapidly.

Correction

Several inaccuracies in an article titled "FBM Accuracy Starts with SINS," published in Missiles and Rockets, July 25, 1960, pp. 8-9, have been corrected by Sperry Gyroscope Div. of Sperry-Rand Corp., subject of the story.

The following comments plus statements extracted from a Sperry letter recently received by M/R will clarify the situation.

The M/R story said, in effect, that 12 Sperry Mark III SINS had been delivered to the Navy and that starting in July 19 more would be delivered. This statement, based on a Sperry-Navy press release, is incorrect.

Sperry's recent letter stated: "The article attributes us with the delivery of 12 Mark III Inertial Navigation Systems. Sperry has delivered 12—as a matter of fact, by now we have delivered 16—inertial systems, but technically speaking these are Mark I, not Mark III systems. The major difference between the Mark I and the Mark III is a changeover from an analog to a digital system."

The article further stated that Sperry's Mark III SINS would be installed on the third and fourth *Polaris* subs. This was drawn from the same source and is also incorrect. Actually, Mark III SINS will be installed on the third and fourth subs of the second series.

North American's Autonetics will provide its Mark II SINS for all five of the 598 Class submarines.

Sperry's clarification said: "Our new type SINS, the Mark III, is scheduled to go aboard the four 608 Class submarines and, beginning with this serics, Sperry has thus far delivered one."

GE Noise Communications System Promises Top Security

A new noise communications system being developed by General Electric's Heavy Military Electronics Department may prove to be the most secure system ever designed.

The company says signals transmitted by this system will be "as difficult to detect as a needle in a haystack."

Called "Phantom," the broad-band communication system receives and transmits intelligent noise or static. It is a radical departure from conventional narrow-band military communications technique where each radio link is allocated a specific narrow bandwidth to avoid interference and to crowd as many channels as possible into the electromagnetic spectrum. In broad-band communications the transmission bandwidth is many times larger than the intelligence bandwidth.

For military communications, broad-band techniques provide three types of security: security against jamming because of the tremendous amounts of power required to interfere with the transmitted signal; transmission security since the average power is spread over a wide bandwidth making the signal extremely difficult to detect; and message security in that even if the signal is detected, it can be made very difficult for an unauthorized listener to understand what is being transmitted.

• **Special bandwidths**—The system uses a special form of double side-band transmission, resulting in bandwidths much greater than those in conventional practice. The prototype Phantom equipment is designed for use in long-haul, high frequency circuits where multipath conditions are encountered; however, it can be operated at frequencies much lower or higher than HF (3-30 mc) without any major design changes. Its operation is not restricted to any particular frequency, GE says.

Since the system's average power is spread over such a large bandwidth, conventional narrow-band circuits operating within the Phantom channel are unaware of its presence. In normal operation, the Phantom signal appears as random noise, or ordinary static, to conventional receiving equipment.

The data rate of the system is purposely kept low in relation to transmission bandwidth. This provides excellent jamming immunity and allows Phantom to be operated in heavily congested portions of the r-f spectrum. The system can tolerate the interference caused by other signals, and at the same time these other signals provide "cover," which enhances the transmission security of Phantom.

In order to receive the Phantom transmissions, an authorized receiving station must not only have the proper equipment, but also knowledge of the operating frequency and the specific signalling wave form being used. Present Phantom equipment has many hundreds of thousands of signalling waveform selections available which can be changed as often as necessary. Two Phantom systems operating in the same frequency band—but using different waveform selections—will appear essentially as random noise to one another. Conventional radio transmissions falling in the Phantom channel also appear as random noise to the system.

Comparable to a combination lock, Phantom is designed so that it can still perform its military communications function even though an enemy knows its frequencies and how it operates.

• **Over 2000 miles**—According to GE, feasibility of the system was conclusively proved during recent field tests when signals were beamed successfully more than 2000 miles.

General Electric engineers working at the receiving site during the field tests with conventional equipment—even though they knew what to look for—were unable to locate with any certainty the signal being received by the Phantom equipment nearby. Many different frequencies in the HF band were used during the tests.

THIS 100-ft. antenna at General Electric's Heavy Military Electronics Department, Syracuse, N.Y., was used to receive signals during recent field tests of the Phantom broad-band communication system.

High frequency was selected for the field tests because of the severe multipath and interference conditions normally encountered in this frequency range. Besides point-to-point communications, GE foresees application of Phantom in aircraft and satellite communciation systems.

Thermionic Converters Near Market

Practical thermionic converters are now being produced in quantity by General Electric and are expected to be on the market next month. Present output of the pilot-line operation in Schenectady, N.Y., is 60 per week. According to the company, capacity could be stepped up to 100 per week.

These first devices—type Z-5386 vacuum thermionic converters—produce one watt with a minimum thermal efficiency of 2.5%. Each is the size of a silver dollar and weighs three ounces. Cathode temperature is approximately 1100°C.

GE is also pushing research and development in vapor thermionic conversion. Plans are to produce and market the vapor type at a later date. The company believes that outputs up to 20 watts per square centimeter of cathode surface and thermal efficiencies as high as 30% can be attained.

Thermionic converters transform heat from any source—the sun, nuclear reactors, isotopes, chemical and fossil fuels—directly into electricity. They can operate on waste heat from other power-generating methods.

Such devices are particularly attractive as power sources for space applications. Commercial possibilities exist for remote areas on earth.

ONE-WATT vacuum thermionic converter produced by General Electric's Power Tube Department will be commercially available next month. The close-spaced sealed-off unit has minimum power density of 0.2 watts per square centimeter of cathode surface and thermal efficiency of at least 2.5%.

At record WESCON show . . .

Packard Reminds Industry of Its Duty

Los Angeles—Hewlett-Packard president David Packard gave his fellow electronic industry managers a talking-to on responsibility last week—spearing at those who would like to pull out of defense work.

Opening up the sixth annual Western Electronic Show and Convention, Packard said the ever-mounting dependence upon electronics by the military had thrust the burden of leadership upon the industry. "We are the heart and nerve center of America's defense effort," he said, adding pointedly:

"The hope . . . that our industry can and should become less dependent on military work is sheer wishful thinking that borders on irresponsibility.

"It will be the continuing task of the electronics industry to add to our military strength for many years . . . "

WESCON, sponsored by the Western Electronic Manufacturers Association and the Seventh Region of the Institute of Radio Engineers, this year drew a record attendance of 40,000 to the Los Angeles Sports Arena. The show was permeated with serious technical presentations, rather than headline-hunting predictions that usually crop up in meetings of this type.

On this note, Dr. William V. Wright said microelectronics pioneered in the U.S. has done much to keep this country abreast of Russia in space.

• **'We launch brains'**—Dr. Wright, who is manager of Electro-Optical Systems Inc.'s Solid State Division, remarked that "Russia launches weight, we launch brains." He said the United States certainly leads Russia in collecting space data.

As an example of microelectronic technology, Dr. Wright demonstrated a silicon disc device that reports the position of a spot of light focused on the disc's surface. He said the radiation tracking transducer could be applied to space navigation systems, satellite tracking, antenna orientation and advanced communications systems. With some modification, the same unit can detect infrared radiation.

Much comment was stimulated by a paper presented by Bernard Baldridge of General Electric's Light Military Electronics Department. He pointed out the danger of pollution of electronic environments by inadequate systems planning.

Denigrating the current emphasis on experts and specialists, Baldridge cited the need for more "generalists" who understand overall system problems, causes and effects. He said the experts must understand that the interactions of our society preclude working in anything like a vacuum.

The ultimate systems interaction, he said, might be a runaway satellite transmitter powered with solar batteries which would require intercept and destruction to permit the frequency to be used again.

Dr. Eberhardt Rechtin, telecommunication division chief at Cal Tech's Jet Propulsion Laboratories, received the 1960 Achievement Award of the IRE Seventh Region. Dr. Rechtin was cited for "research in communications systems and leadership in setting up deep space communications stations."

TECHNICAL

Los Angeles—A new approach to semiconductor micro-component packaging was reported at WESCON by Thomas C. Hall of Pacific Semiconductors, Inc.

This was one of a number of advances in the rapidly-expanding technology of microelectronics described at the meeting's technical sessions.

The Pacific Semiconductor technique employs surface passivation, which Hall defined to mean the generation on the semiconductor surface of a chemical film layer which does not adversely affect electronic properties of the surface leading to good device characteristics.

In addition, it provides electrical stability of the surface as well as isolation from electrical and chemical influences which might lead to deterioration.

Hall said that in addition to improved performance and reliability, significant and critical advantages in micro-miniaturization and fabrication are achieved.

He said an order of stability exceeding that obtainable with the best hermetic packaging has been obtained by generating oxidic layers of altered composition and structure on silicon surfaces. These films are attached by strong covalent chemical bonds to the crystal substrate.

Substitution of various organic groupings into the structure of the oxide film renders the film water repellent.

Hall listed these advantages of surface passivation packaging over hermetic packaging of semiconductor devices: improvement in reliability, reduction in size, superior performance, simplification of manufacture and extension of state-of-the-art limits.

• **Layer deposits**—D. J. Shombert and J. Allegretti of Merck, Sharp & Dohme told of a method of depositing layers of single crystal silicon on single crystal silicon substrates. This alternation of layers of controlled resistivity and type was said to permit the introduction of many functional elements directly into a structure. They said elements deposited experimentally in five and seven layer structures include capacitors, resistors, rectifiers, voltage limiting Zener diodes, pnpn transistors and solar cells.

A number of speakers dealt with micromodules, in which interest has been increasing during the year. Radio Corporation of America, in fact, offered what it termed a Basic Micromodule Laboratory specifically intended for electronic equipment manufacturers interested in the conversion of existing systems to the micromodule form. It was described by D. T. Levy.

He said the simple laboratory permits equipment design engineers to design, assemble, and evaluate experimental micromodules in a minimum of time. Taking up 10 ft. of lab bench, the equipment includes not only an air-abrader and process control unit, a stereoscopic microscope, solder-coating equipment and a curing oven, but also all necessary small tools, chemicals, jigs and fixtures. It includes a small but adaptable stock of microelements and even an instruction booklet describing the principles of micromodule construction and the methods by which complete electronic circuits may be divided into individual micromodule units.

The laboratory is intended for design engineers as a research tool for building and testing experimental micromodules, not as a production unit, RCA emphasized.

Robert G. Rockwell, Varian Associates, reported on development of a new klystron tube weighting eight oz.

Defense

EQUIPMENT

Los Angeles—Outstanding missile and space electronic equipment on display at the recent WESCON show ranged from a large high-performance tape recorder which cost $2-million to develop to an infrared detection device smaller than a lipstick.

The tape recorder was an all solid-state advanced recorder selected by Boeing Airplane Co. for testing of the *Minuteman* missile. It is being used as the primary recorder/reproducer of a telemetry ground station.

The FR-600 recorder developed by Ampex Corp., Redwood City, Calif., also took one of five outstanding design awards at the show. The Ampex recorder is the primary unit of a test system to record telemetry signals during pre-flight, launch and flight.

First production models of the recorder were shipped recently to the Boeing Seattle plant. Seventeen of them will be used in the test program. A normal two and one-half year product development period was compressed into 18 months to meet requirements of the *Minuteman* program, Ampex says.

First nine recorders shipped to Boeing have a frequency range of 300 cycles to 250 kilocycles per second with a 60 ips tape speed. Although this is more than double the bandwidth previously available, Ampex reports that circuitry and magnetic head improvements now are being engineered to extend the bandwidth of the remaining eight Boeing recorders to provide for recording up to 500 kilocycles at a tape speed of 120 ips.

• **Early application**—Boeing's use of the recorders was one of the first major applications of serially recorded data for missile programing. At a tape speed of 60 ips, information is transmitted to the recorder at up to 350,000 bits per second.

Boeing selected a 7-track configuration for the *Minuteman* testing, although the recorder is capable of handling up to 14 tracks on inch-wide tape.

The tape-recorded data in the telemetry system is the primary information source to a tape format convertor. The information is pulse-code-modulated and frequency-modulated telemetry data. Ampex reports that the output of frequency-modulated receivers, containing serial coded PCM information, is redundantly recorded for reliability on three separate tracks.

Remaining four tracks are used for recording conventional FM/FM telemetry signals and other information.

Some of the recorders sent to Seattle will be re-shipped to Edwards Air Force Base, Calif., and Patrick AFB, Fla., after checkout by Boeing system engineers.

Ampex says an all solid-state modular electronic system was chosen to assure minimum down-time and high reliability. Modular packaging permits quick replacement of individual electronic units and the solid-state devices do not require the 30-min. warmup time associated with vacuum tubes. The recorder is applicable to other advanced missile systems.

The lipstick size infrared detector was developed by Raytheon Co.'s Microwave & Power Tube Infrared Devices Laboratory at Waltham, Mass.

The device is for use in detection units pinpointing missiles, launching pads or rocket motor test areas.

The passive beamless unit is said by Raytheon to be the smallest known metal-encased unit in the field of infrared detectors, less than two inches long.

The company says the new detector's long-range operation, its small size and metal casing make it particularly applicable to missiles.

• **Some highlights**—In other developments at the WESCON show:

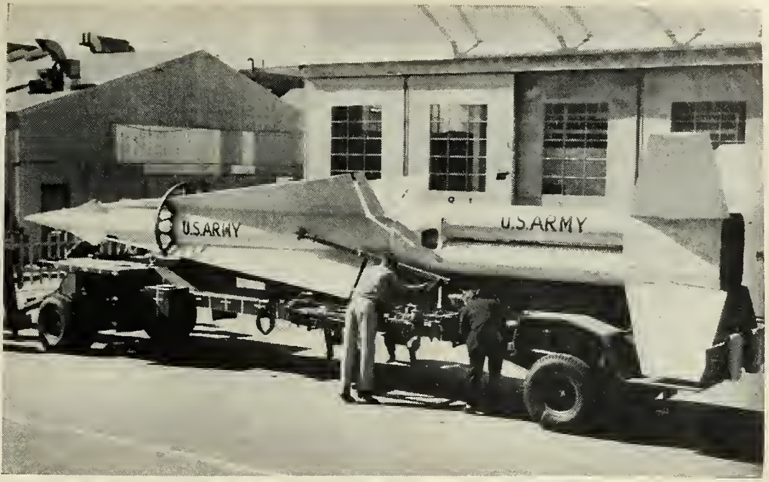
Mincom Division of Minnesota Mining and Manufacturing Co. introduced a new video band recorder/reproducer which it said could simulate an actual missile flight by feeding original data back to the receiver in the missile.

General Electric's Receiving Tube Department displayed application of ceramic tubes as part of an ultra-high frequency transmitter built by Space Technology Laboratories. The ceramic tubes in Resdel Engineering Corp.'s identified by GE as a 7486 radio-frequency oscillator triode and a 7296 VHF-UHF power amplifier. The STL communication unit was designed to transmit two watts of CW power from a space vehicle 10-million miles from earth. GE also showed use of ceramic tubes, currently in production, were "UDOP" UHF Doppler velocity, acceleration and position systems, which have successfully flown in all *Pershing* missiles, as well as ceramic tubes in a miss-distance indicator built by the Ralph M. Parsons Co.

Leach Corp. displayed a 24-oz. tape recorder carried by Air Force Capt. Joseph Kittinger to record medical data on 14 separate magnetic channels during his 19½-mile leap from a balloon. It was learned that Leach has under development one half as small, 10½-oz.

Corning Electronic Components, Corning, N.Y., announced plans to market one-watt and half-watt high quality film resistors in direct competition with composition resistors. The one-watt resistors will sell for 6.1 cents, the half-watt for 5.9 cents.

Collins Radio Co.'s Western Division, Burbank, Calif., unveiled mechanical filters with ferrite transducers for the first time. Improved performance was said to result from replacing of former nickel-alloy material with the ferrite transducers.



Nike-Hercules Goes Mobile

THE ARMY shows the mobile Nike-Hercules for the first time. The Western Electric air defense missile—now packing an antimissile punch—is mobilized with a Douglas M-94 field installation kit including jacks, outriggers and blast deflector.

BMD beefs up . . .

Air Force Satellite Program Gets New Boss

Greer will bring sharp eye to job of expediting Midas, Samos and Discoverer

by Clarke Newlon

The man the Air Force has selected to boost USAF satellites higher—and to do it faster—is a tall, lean West Pointer, class of '39, a command jet pilot and an electronics engineer who catches errors in computers.

He is Brig. Gen. Robert E. Greer, who will assume his duties as Vice Commander of the Air Force Ballistic Missile Division for Satellite Programs on October 1. Actually, he is already spending more time in the BMD offices at Englewood, Calif., than his own at the Pentagon where he was Assistant Chief of Staff for Guided Missiles.

General Greer's assignment as satellite boss and expediter comes coincidentally with word from California that BMD will hike its personnel from a present 2000 to nearly 7000 in the next two years and to 12,000 in the coming 4-5 year period. Eventual payroll: $100 million annually.

In Bob Greer's Pentagon office he kept an old-fashioned school-room blackboard hanging by his desk. In the course of a normal conversation he would cover it with mathematical equations, sometimes to satisfy his own thinking, sometimes to clarify a point. The mistake the computer had made was not really the computer's fault. It had been fed one bit of wrong data. Neither the computer nor Greer knew this but only Greer knew the answer was wrong.

One of the general's main jobs at BMD will be to push the *Midas* and *Samos* programs, but it will be more to keep a critical eye on the entire Air Force satellite schedule, as his job title indicates.

Under his sharp scrutiny will come, in time, the *Discoverer* satellites, one of the next two of which will probably put a monkey in space and, hopefully, recover it.

General Greer was not, he says, too impressed with the latest feat of the Russians in putting their menagerie in orbit and recovering it. But the reason he was not impressed was, he said, that it had been apparent for some time they had such a capability.

- **On Soviet ability**—Will the Russians put a man in space?

"No doubt of it," he said. "Not the slightest doubt."

"When?"

"Within the next six months," he thought and then qualified that. "Make it the near future."

"Like October?"

"It's possible," he said. "Mostly it depends on their program, on how flexible it is. They may have programed more than one shot carrying animals and if their program is rigid, they'll do that again. If they are flexible they could wipe out animal shots and go right on to man. Or, they may have planned only one animal shot.

"Actually," he continued, "now that they have proved they can land a capsule where they want it and land it safely, the feat of putting up a manned vehicle is simpler than an unmanned.

"In the unmanned operation you have to depend on servo-mechanisms and pre-programing. They have definite limitations. A man in the satellite, though, makes things much simpler. He can think and react. He can look up or down and figure out his position for stabilization. He can focus a camera, fire a retro rocket, handle controls and guidance. He's about the best servo-mechanism ever built."

General Greer felt that some of the long Pacific Ocean shots made by the Russians were tests for the menagerie shot and for the manned capsule which will follow it.

The Soviet feat of landing their capsule with an accuracy of six or seven miles he thought showed high technical skill and high confidence in that skill. He also explained how he thought they had accomplished such precision.

The Russians, he said, have sufficient thrust in their booster to carry aloft an inertial guidance system, regardless of weight. They can guide their satellite into exactly the orbit they wish. Knowing the exact orbit they can also predict where it will be at any given second, kick it out of orbit with a retro-rocket and land it with great accuracy.

Because our *Thor-Agena* has not sufficient thrust to lift the *Thor's* inertial guidance system as well as a payload, guidance is forfeited. The *Discoverer* satellites are guided into orbit by an auto pilot which is preprogramed and which cannot correct for wind drift or gyro error, for instance.

Hence, without precise knowledge of the orbit the U.S. satellite recoveries have to account for a much greater margin of error—a margin figured in 200 or more miles instead of 10.

This is also the reason the U.S. recoveries are scheduled over water instead of land—to prevent the possibility of a satellite landing on, say, Los Angeles.

Navy & Air Force Bullpup

Air Force Mace

Army Lacrosse

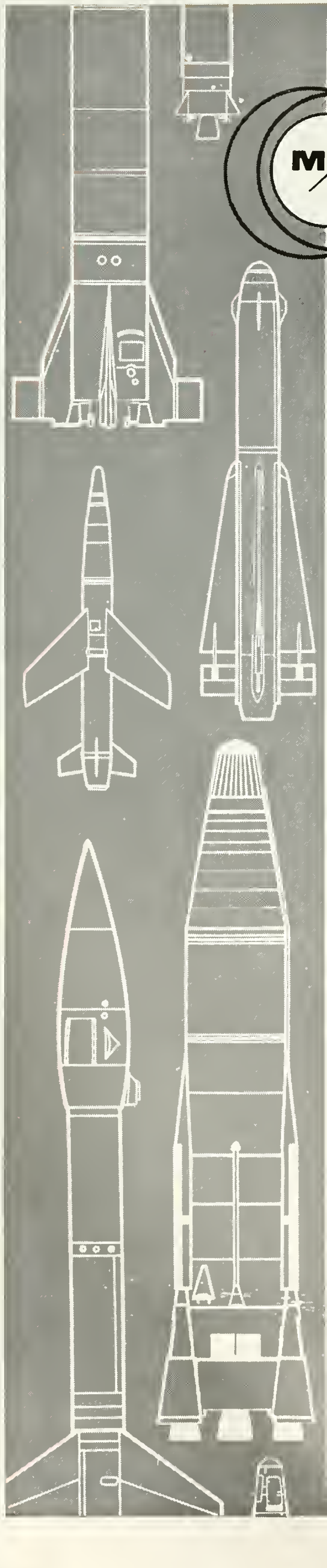
Army Pershing

At $00^h00^m01^s$ GMT, September 1, 1960, Martin logged its 658,008,000th mile of space flight

Air Force Titan

Five major U.S. missiles developed and built by Martin

MARTIN



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- Research Laboratories, United Aircraft Corp.
- Rocket Power, TALCO
- Schweber Electronics
- Snap-Tite, Inc.
- Societe d'Etude de la Propulsion
- Sperry Gyroscope Co., Div. Sperry Rand
- Stalker Corp.
- Stanpat Co.
- F. W. Stewart Corp.
- Stromberg-Carlson, San Diego
- Summers Gyroscope Co.
- Sundstrand, Denver
- H. I. Thompson Fiber Glass Co.
- Uni-Flex Manufacturing & Engineering, Inc.
- United Technology Corp.
- D. Van Nostrand Co.
- Vector Manufacturing Co.
- Veeco Vacuum Corp.
- Westrex Corp.
- Wonder Building of America
- Zippertubing Co.

THE MISSILE/SPACE WEEKLY

missiles and rockets

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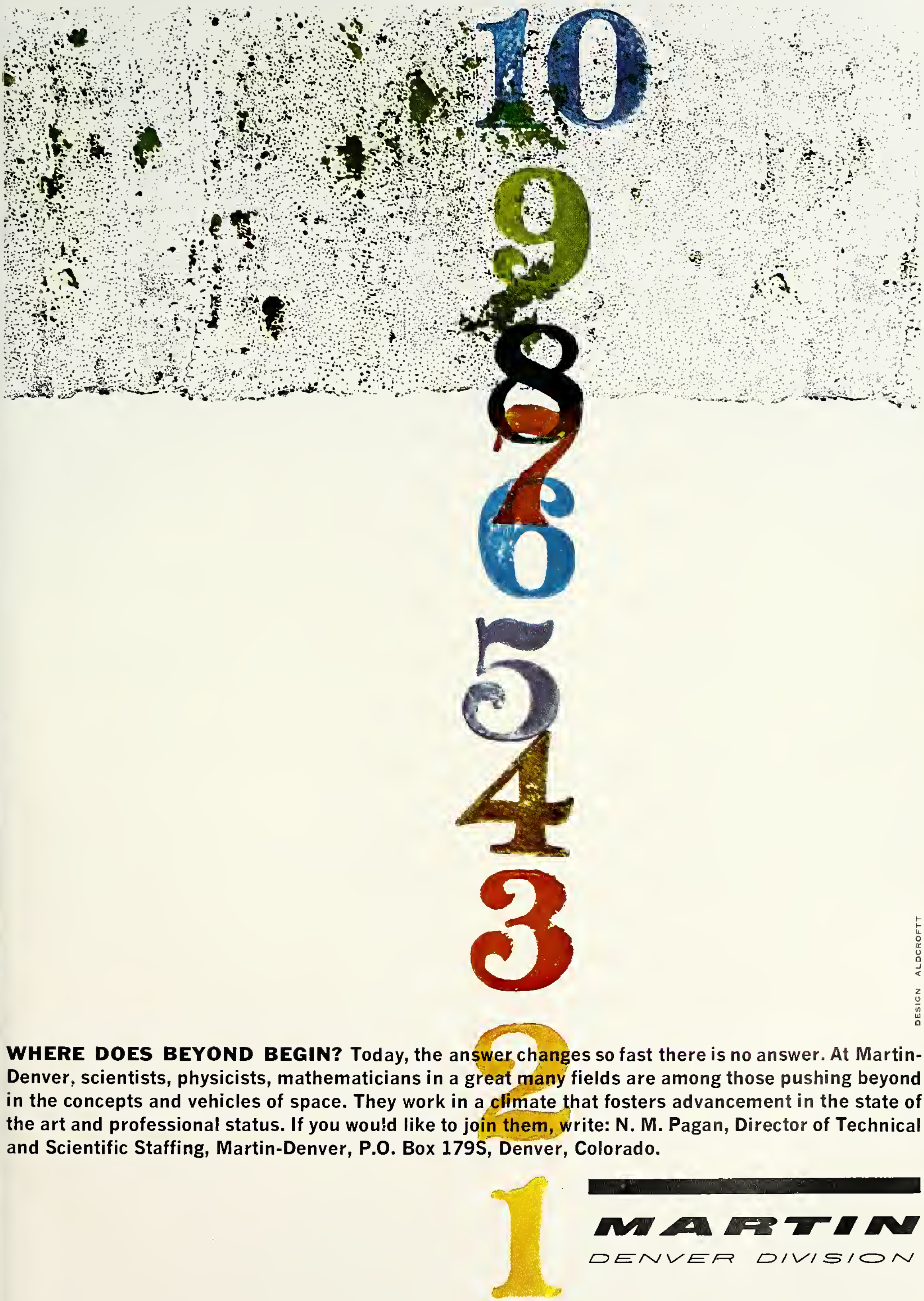

DESIGN ALDCROFTT

WHERE DOES BEYOND BEGIN? Today, the answer changes so fast there is no answer. At Martin-Denver, scientists, physicists, mathematicians in a great many fields are among those pushing beyond in the concepts and vehicles of space. They work in a climate that fosters advancement in the state of the art and professional status. If you would like to join them, write: N. M. Pagan, Director of Technical and Scientific Staffing, Martin-Denver, P.O. Box 179S, Denver, Colorado.

MARTIN
DENVER DIVISION

NIKE-ZEUS

Repeated successful R & D launchings of the U. S. Army anti-missile missile have demonstrated the capability of its Thiokol booster to start the missile on its way to reach high altitudes in seconds. The Zeus' Thiokol motor boasts highest thrust of any single solid rocket in the free world... 450,000 pounds. Thiokol means reliability!

Prime Contractor: Western Electric. Missile: Douglas.
Booster Motors Propulsion Contractor: Thiokol.

THIOKOL

Thiokol® CHEMICAL CORPORATION, BRISTOL, PENNSYLVANIA
Rocket Operations Center: Ogden, Utah
Nike-Zeus Motors produced at the Redstone Division

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Technical Countdown

ELECTRONICS

Titan II Guidance To Fly Next Spring

First flight test of AC Spark Plug's all-inertial guidance system reportedly will be in the spring of 1961. Touted as extremely accurate, the system also features small volume (1.1/3-cu.-ft.) and weight (below 200 lbs.).

Cosmic Deluge Upsets Theory

MIT physicists believe they have recorded the heaviest cosmic-ray shower ever observed. Because of its unusually high energy level, scientists believe that the source was beyond our galaxy (which conflicts with present theory of cosmic ray origin). Detected in Albuquerque, N.M., last Dec. 3, the shower rained down 10^{10} atomic particles during a period of only 10 microseconds. The primary cosmic ray causing the shower had energy from 20 to 40 billion bev, scientists said after a three-month analysis.

Thermionic Converters Available Soon

One-watt vacuum thermionic converters are now in pilot production at General Electric's Schenectady plant. The 3-oz., 2-in.-dia. miniature power sources will be commercially available by October, says GE. For the near future, the company is developing vacuum-type converters with 5-w output and cesium vapor-type converters with up to 20w/sq.cm. output. Until now, all of GE's production has been for its own missile/space use.

No Shadow Operation For Echo

The *Echo I* radio beacon is now operating solely on its solar cells. The beacon goes off each time the balloon satellite moves into the earth's shadow. The balloon remained almost fully inflated during the first few shadow crossings.

Self-Cooled Accelerometer Developed

An integral self-cooling system for accelerometers, patented by Dr. Leslie Gulton, will allow the sensing units to endure temperatures of more than 2000°F. An expansible gas under ultrahigh pressure—released at prespecified temperatures into an expansion chamber surrounding the accelerometer—absorbs heat and cools the wall enclosing the instrument.

Thermoelectric Units Both Heat and Cool

Temperatures of crystal filters in an IR detection system were controlled within 0.5°C by Westinghouse thermoelectric cooling devices in a recent *Aerobee-Hi* rocket shot. The NRL probe was reported to be the first use of such devices for both heating and cooling.

GROUND SUPPORT EQUIPMENT

Titan Base Wiring Prefabricated

Wiring and cabling for an entire *Titan* base is prefabricated in the factory in a new technique developed by Martin. The prefab harness—widely used in mass-production of electronic chassis but never before extended to such heavy cable and long runs—is said to be quicker, cheaper and more reliable than conventional methods.

Contract Awarded for HIPAR Radars

General Electric HMED has been awarded a $14.5-million production contract for high-power acquisition radars (HIPAR) for Army's improved *Nike-Hercules*. This radar—reported to triple the effectiveness of the weapons system—was credited with the recent successful kill of one *Hercules* by another.

PROPULSION

Hydrazine by Neutron Bombardment?

Fissio-chemical production of hydrazine from ammonia—by bombardment with neutrons from a nuclear reactor—is under investigation by Aerojet-General Nucleonics as a possible means of cutting cost. A-GN is making the study under an Air Materiel Command contract.

Secret Test Lab Revealed

Full-scale component testing with liquid hydrogen is conducted at a hitherto secret AiResearch facility near Boron, Calif. The test center, built in 1957 for the Air Force, is capable of evaluating liquid hydrogen pumps and heat exchangers.

ARC Broadens Scope

Atlantic Research has moved into the ramjet fuel business. Wright Air Development Division last week awarded ARC a contract for development work on high-volumetric-heating value slurry fuels. Combustion testing will be subcontracted to Marquardt Corp.

ASW ENGINEERING

Environments Differ, Techniques Same

Convair is using flight-test data techniques to record temperatures of underwater waves under a one-year, $130,000 Office of Naval Research contract. Data recording and processing methods are acquiring and handling information five times as fast as those now in use for oceanography.

No Hams; It's Fish or Fowl Operators

American Electronics Laboratories, Inc., Phil., has developed for the Office of Naval Research a tiny radio transmitter to be carried by pigeons. It has a 2-week life and a 22-mile range. A later model for attachment to an albatross will have an 800-mile range and a five-month lifetime. Marine biologists are looking at the transmitters for possible attachment to sharks, porpoises and whales to send back internal and external data.

ADVANCED MATERIALS

High-Temperature Alloy for Pluto

Vital components for the Project *Pluto* nuclear ramjet engine will be fabricated from Sierra Alloy, a high-temperature, radiation-resistant material from American-Marietta Co. *Pluto* is slated to be the propulsion source for *Slam*, a low-level supersonic weapon.

Titan II Will Get Mor
Payload i

DENVER—*Titan II* will be developed with tooling, testing and electronic facilities based on those designed for *Titan I,* but with greatly improved performance, reliability and reaction time, Martin-Denver says.

The company expects to phase its facilities here from the original version of the two-stage ICBM to the follow-on version with a minimum of effort and complication.

The biggest single change from a tooling point of view is the expanded diameter of the second stage from eight to ten feet, equalling the first stage size. Materials used in the two systems will be identical in most cases, jigs and fixtures will apply to both, and fabrication techniques will be equally applicable.

Testing, to be conducted here with the exception of actual flight, will all be handled in *Titan I* facilities. Test stands D-1 and D-2 are now being retrofitted for the 108-ft.-long *Titan II.* Static tests of the complete missile are expected here next year.

Tests of components and subsystems are already being carried out and Aerojet-General Corp., the propulsion system contractor, has been testing the storable engines for several months.

• **Accent on simplicity**—The prime interest in the *Titan II* system is reliability, not optimum theoretical performance. As one program executive remarked: "The first engineer who suggests a design modification in the interests of sophistication will promptly be shot."

Range of the storable-fuel missile will be in excess of 12,000 miles, according to Martin. This figure is based on a payload weight equal to that of *Titan I.* Despite its heavier payload, *Titan II* is expected to surpass the range capability of any other ICBM system.

Some structural "beefing up" will be provided for two major reasons: the requirement for an in-silo launch, and the denser nature of the storable fuels. The former beef-up results from studies

Range and Production Line Modification

by Frank G. McGuire

First stage of Titan I is shown on production line at The Martin Co.'s Denver Division.

of acoustical and vibration factors present in an in-silo launch.

The Aerojet engines will provide the *Titan II* with slightly greater thrust than its predecessor, through a series of modifications to the powerplant. The engine will have a space-start capability, making it useful as an upper stage for future extremely large boosters.

Most of the additional ten feet in length will be accounted for by tankage in the first stage. A slight increase in second-stage length will be used for the payload compartment, making possible a larger warhead. The second-stage tankage increase will result from the enlarged diameter, not lengthening.

- **New sequence**—Additional changes are planned in subsystems, such as the stage separation sequence. In the *Titan II* sequence, the second stage will ignite while still connected to the first stage, and the engine blast will insure separation. An interstage connector will have a number of slots located about its periphery to allow initial escape of engine gas and flame until separation is positively achieved. Velocity at this point is about 6000 to 7000 feet per second. The *Titan I* system called for a delay in second-stage ignition until the two stages were about 15 ft. apart.

The 15-ft. distance was supplied by two solid rockets mounted on the second stage. These performed the dual function of aiding separation while supplying a positive force to feed fuel to the second-stage turbopumps. Without this force, Martin said, there was danger of the liquid forming globules and floating around the tank in weightless condition.

Accuracy of the engine cutoff is believed to be such that verniers will not be required for final velocity and course correction. *Titan II* will, if this is true, have an extremely clean configuration and simple operation sequence.

Mass ratio of *Titan II* is believed to be roughly equal to that of its predecessor, about .94. (The German *V-2* had a mass ratio of about .57).

An all-inertial guidance system by AC Spark Plug will replace the present radio-inertial system supplied by Bell Telephone Laboratories. The re-entry vehicle will be made by General Electric.

The scheduled launch in October of a *Titan I* from its silo at Vandenberg AFB is designed to test certain *Titan II* design features. These will consist mostly of structural changes, including the modification of chemical milling areas to reflect the altered requirements of strength vs. weight.

- **Production**—Martin plans no production lots for the *Titan II*, primarily because it is being designed from the start as an operational configuration and will undergo as few engineering changes as possible, consistent with system reliability and simplicity.

The entire *Titan I* vehicle is estimated by Martin to have "fewer parts than the nose section alone of some modern combat aircraft." Spares will be selected from the approximately 23,000 line items in the missile and kept on hand at maintenance and overhaul depots, such as the San Bernardino Air Materiel Area. Parts in *Titan II* will probably number significantly less.

The company estimates that chemical milling applied to the fabrication process has reduced weight of the vehicle by 900 to 1000 lbs. Although the exact areas to be chemically milled on *Titan II* are not yet determined, a comparable weight saving is expected.

Basic airframe material on *Titan* is 2014 aluminum alloy, supplied by Dow Metal Products Co., Harvey Aluminum, and Alcoa. Martin devised special welding methods for the alloy, due to its undesirable characteristics. The excellent strength-to-weight ratio of 2014 led to its choice.

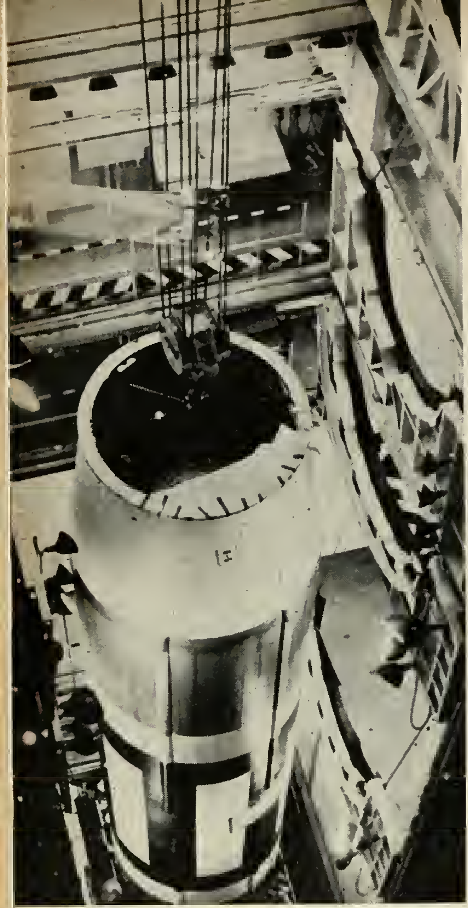
- **Welding**—Manufacturing development engineers at Martin established a process using an inert-gas shielded tungsten arc with an aluminum filler wire. It was found that this also kept the heat-affected zone in the parent material to a minimum.

Tensile strength in the welded joint is maintained through use of an aluminum backup chill bar which dissipates heat. A steel plate located under the butt joint prevents the parent material from adhering to the fixture during welding.

The overall welding technique is roughly similar to that used in welding magnesium-thorium alloys on the *Polaris* FBM.

- **Panel treatment**—Extruded panels are received from suppliers in a semi-hardened condition, and are subsequently machined in order to maintain a tolerance of 0.050 in. thickness.

One supplier of skin panels, Dow, extrudes them in a 13,200-ton press at its Madison, Ill., plant, one of the three largest such presses in the world. Panels are extruded in "U" and "V" shapes to



FIRST STAGE of a Titan is lowered into place in a cell of the Vertical Test Fixture. Here, for first time in production sequence, both stages are mated.

achieve a required 34-inch width. They are then straightened and flattened to close tolerances. Flatness tolerance in bend areas on the stiffener side is 0.030-in.-convex, and the side 0.030-in.-convex-or-concave.

Panels are extruded in 37.-ft. lengths —the "U" shape being used for panels with three stiffeners, and the "V" shape for panels with two stiffeners. After the flattening process in Dow's contour-correction equipment, panels are sent to the stretcher for desired percentage of stretching.

Machining at Martin-Denver is done on the flush surface of the panel, using a tape-controlled Giddings and Lewis Mill, then on the reverse side between the "T" shaped stringers.

Following machining, panels are mounted on a Kirksite contour block, placed in another stretch press and formed to the proper radius. The Hufford press used in this operation is reputedly the first of its size and capacity to be used in the industry. It has a 1400-ton capacity and measures 43 ft. long, 11 ft. wide and 20 ft. high.

Chemical Milling follows the stretch press operation. Neoprene base materials prevent the etching solution from attacking portions of the panel to be kept constant. The neoprene is scribed, after being cured, and by peeling off selected sections Martin has in effect a template which determines where the alloy will be affected by the etchant.

• **Assembly**—The *Titan* is composed of twelve of these panels, which are assembled in a locating fixture in groups of three and automatically welded together longitudinally. The locating fixture, custom-built for the *Titan* program, consists of a bed assembly, locating and clamping paddles, a welding bridge and the automatic welding head with its control system.

The "T"-shaped stringers running the length of each panel are used by the pneumatic clamps to hold the panel in position on the weld fixture. Three panels at a time are welded into a quarter-barrel assembly.

After four of these quarter-barrel assemblies are complete, they are clamped to the locater paddles and welded together to form the complete barrel which constitutes the *Titan* airframe. Upon completion of this operation two electrical cutting heads trim the ends of the barrel.

Domes to form the ends of tanks for the vehicle were fabricated in "orange peel" fashion until the development of equipment which could fabricate them of fewer segments, including a specially-formed dome cap with formed-in outlets for liquid flow.

After completion of welding on the dome itself, two of the finished domes are placed in chucks on a welding fixture, while a completed barrel assembly is placed between them on a rolling base. All fixture segments are synchronized so that they roll together, resulting in butt joints being formed by component edges. The weld is performed by a fixed welding head, which remains in one position while the workpiece rotates before it, thus accomplishing the job in one pass.

Both visual inspection and the use of a dye penetrant are utilized to verify the integrity of welds. All welds of tank panels, domes and finished barrels are checked by X-ray techniques as well.

Following X-ray tests, tanks are subjected to hydrostatic operations, which accomplish testing, cleaning and finishing of metal surfaces. Hot air and nitrogen are then introduced into the tank, one after the other, to dry it and reduce the dew point to 10°F. Finished and tested tanks are then sealed.

Tankage assemblies, engine fairings, inter-tank structures and transition assemblies are then positioned in fixtures for joining.

• **Testing**—Because of the extreme reliability required of *Titan*, Martin-Denver has adopted a building-block approach to testing. Components, then subsystems, then complete systems are checked out thoroughly. Electrical components and harnesses are bench-tested, and relays are subjected to simulated missile electrical loads.

Hydraulic and pneumatic subsystems are tested against specifications in facilities with up to 15,000 psi hydrostatic pressure available.

Upon completion of the vehicle, the missile is taken to the vertical test facility, a 13-story structure with isolated test cells.

This vertical test facility (VTF) has provisions for completely isolating the missile from outside interference while electrical and electronic checks are performed in one of the nine test cells.

"Marriage system checks" are performed on guidance, control systems, telemetry, pressure lines, and correct sequencing. A complete countdown is carried out, and electronic simulation of engine firing and flight sequences is included.

How Titans Compare

	Titan I	Titan II
Height	98 ft.	approx. 110 ft.
Diameter (1st stage)	10 ft.	10 ft.
Diameter (2nd stage)	8 ft.	10 ft.
Weight	220,000 lbs.	approx. 250,000
Range	7000 stat. mi.	10,000 stat. mi.
Guidance	radio inertial	all inertial
Propellant	liquid	storable liquid
Thrust (1st stage)	300,000 lbs.	400,000 lbs.
Thrust (2nd stage)	80,000 lbs.	100,000 lbs.
Operational	1961	1963

Parts Reduced in Titan II Engine

Switch to storable fuels eliminates ignition system and provides space start capability for big vehicles

SACRAMENTO, CALIF.—The *Titan II* engine is expected to have only about half as many control components and moving parts as the original *Titan* design, according to Aerojet-General Corp., associate contractor for propulsion on both versions of the two-stage ICBM.

The company is relying on simplicity to provide high reliability in the storable-fuel version of the Martin missile.

The estimate of parts reduction includes ground support equipment and reflects elimination of the helium and nitrogen start systems, the ignition systems, and many valves and regulators. Instead of the start systems, solid-propellant gas generators will be used to spin the turbines at launch to feed propellants to the engine.

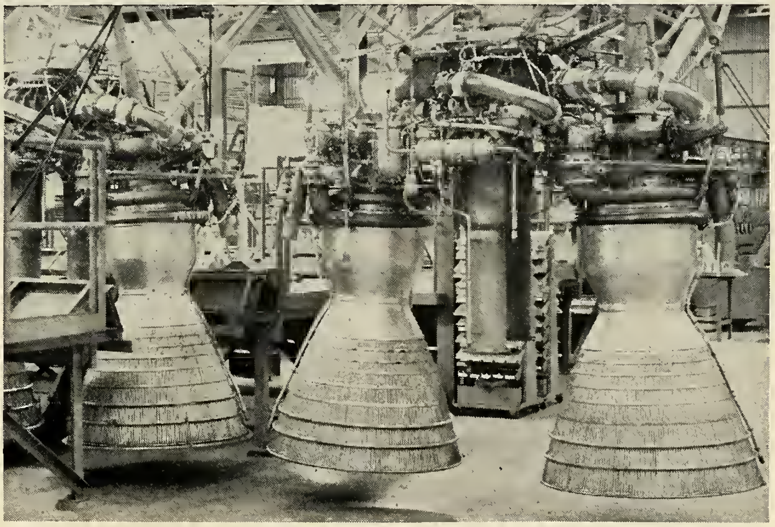
Adoption of storable hypergolic fuels has enabled the company to eliminate the ignition system.

Aerojet has dubbed the storable fuel mixture for *Titan II* "Aerozine-50"; it is a composition of 50% hydrazine and 50% unsymmetrical dimethylhydrazine. Aerozine-50 will team up with nitrogen tetroxide to power the two-stage ICBM with more than 400,000 lbs. thrust in the double-barrelled first-stage engine.

As it did with *Titan I*, Aerojet will follow the now-in-vogue concurrency concept—simultaneous development and production of engines. The phase-in of the *Titan II* on the heels of the *Titan I* model is expected to be relatively smooth.

- **Eligible for space**—An additional feature of the first-stage engine which will have no direct application to the weapon system, but will make *Titan II* a front-runner for any upper-stage job in huge space systems, is the capability of a space start. The hypergolic nature of the storable propellants greatly simplified the problem of starting the big engines in space, and the already proven second *Titan* stage will be a natural companion for third-stage honors atop any new super-booster.

Aside from the great reduction in parts, modifications of the engine for its *Titan II* role will include changing the seals on fuel and oxidizer lines and valves, altering mixing ratios, and re-working injector plates.



FIRST-STAGE ENGINES for Titan I at the Sacramento Liquid Rocket Plant of the Aerojet-General Corp. Titan II first stage will have similar specifications.

Aerojet has been testing a storable-fuel version of the *Titan* engine for several months.

The particular storable fuel mixture chosen for *Titan II* has the following general characteristics: weight mixture ratio of 2.00; volume mixture ratio of 1.24; combustion temperature about 5590°F; characteristic velocity about 5725 fps; and specific impulse approximately 288. These are calculated at 1000 psia, shifting equilibrium and optimum expansion at sea level.

Aerojet is reported to have made some increases in specific impulse performance and other properties. Specific impulse figures for the *Titan II* propellants, for example, have been estimated to be equal to the LOX-RP 1 combination of *Titan I*.

- **Similar specs**—First-stage engine dimensions and specifications for the *Titan II* will undoubtedly follow the *Titan I* design closely. Designated the LR-87-AJ-3, *Titan I's* booster has an overall length of 10 ft., a maximum width of 9 ft., and a gross weight of 3700 lbs. It is a bell-nozzle configuration using regenerative cooling and having an area ratio of 8:1.

Fabricated of stainless steel, the double barrels use common missile tankage for propellant supply. About 250 stainless steel tubes are welded side by side to conform to the properly shaped mandrel and shape the thrust chamber. Burning time is 120 seconds.

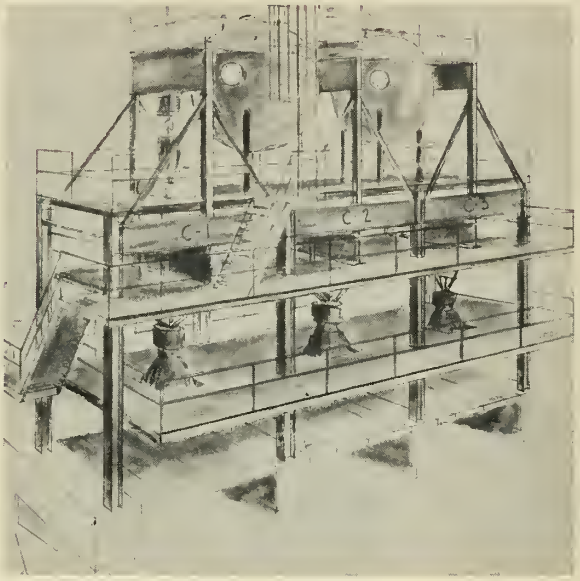
The second stage generates about 80,000 lbs. thrust at altitude (equivalent to about 60,000 at sea level) and is billed as the free world's largest space-started rocket engine. It consumes about 25 tons of propellant during its 150-second burning time.

Designated LR-91-AJ-3, the engine's bell nozzle thrust chamber is partly regeneratively cooled and has an area ratio of 25:1. Entire engine unit is about seven feet long, four feet wide and weighs about 1300 lbs.

When modified for the *Titan II* vehicle, the first and second stage engines will be re-designated LR-87-AJ-5 and LR-91-AJ-5, respectively.

Safety Stressed in A-G's Storable

by Dan M. Tenenbaum
Manager, Test Divisions
Aerojet-General Corp.



THRUST Cham test Stand C-1-2-3 c version depicted in artist's drawing.

COMPLEX of th test stands on each s of control room un bunker in center.

SACRAMENTO, CALIF.—Development of engines for *Titan II* has required some major changes in test facilities at Aerojet-General's Liquid Rocket plant here to accommodate the storable propellants nitrogen tetroxide and Aerozine-50 (a 50-50 mixture of UDMH and hydrazine).

Important modifications include: conversion of engine test stands and a new central storage and pumping facility for propellants; a new remotely controlled continuous mix station for Aerozine-50, so that the constituents can be mixed as they are unloaded from tank cars; a 5½-mile railroad spur for direct transportation of propellants to the storage area, and a number of new safety devices to protect personnel from the possible hazard of toxic vapors.

The present facilities, built for developing *Titan I* engines, were designed to accommodate liquid oxygen and RP-1, a hydrocarbon type fuel. Interim modifications to existing facilities are being utilized for *Titan II* engine tests until construction and conversion of the new facilities is completed late this year.

In the new design and modification work, the most important considerations were the toxic nature of the storable propellants and, hence, the need for extra safety measures for the personnel who handle them. Aerojet's extensive experience with storable-type propellants, posing the same or similar handling problems, has helped greatly in the present rapid changeover. Our experience with storables includes developing rocket engines for assisted take-off of the Air Force B-29, B-45, B-47, and F-84 aircraft; inflight thrust augmentation on the Air Force F-86 airplane; and propulsion systems for the *Aerobee, Bomarc, Nike, Vanguard* second stage and *Able* second stage.

Work on *Titan* engine testing is an around-the-clock operation for 1150 members of the Liquid Rocket Plant Test Division.

- **Test area**—The liquid rocket test area is composed of 24 high-thrust test stands ranging in thrust capability from 150,000 to 1,500,000 lbs. The high-thrust test stands are constructed in groups of three on a common concrete structure referred to as a complex. The basic test stand structure consists of a reinforced concrete base with steel superstructure to accommodate the propellant run tanks and rocket engine thrust mounts.

The 24 test stands are separated into four test zones. Each zone consists of two complexes, operated from a reinforced concrete, revetment-protected control building housing two control rooms, one for each complex. Each test zone also contains a test shop for the maintenance of test stand equipment and instrumentation for checkout of rocket engines and components prior to test.

Each zone has its own gaseous nitrogen, fuel, oxidizer, and water supply and distribution systems. Two of the test stands are capable of simulating altitudes up to 250,000 ft.

A vibration facility is provided for dynamic vibration and shock testing of components and complete engine assemblies.

The high-thrust test facilities are augmented by a fifth test zone which is used for component testing. This facility includes five control buildings—each operating up to four test set ups and a time-versus-volume flowmeter calibration facility.

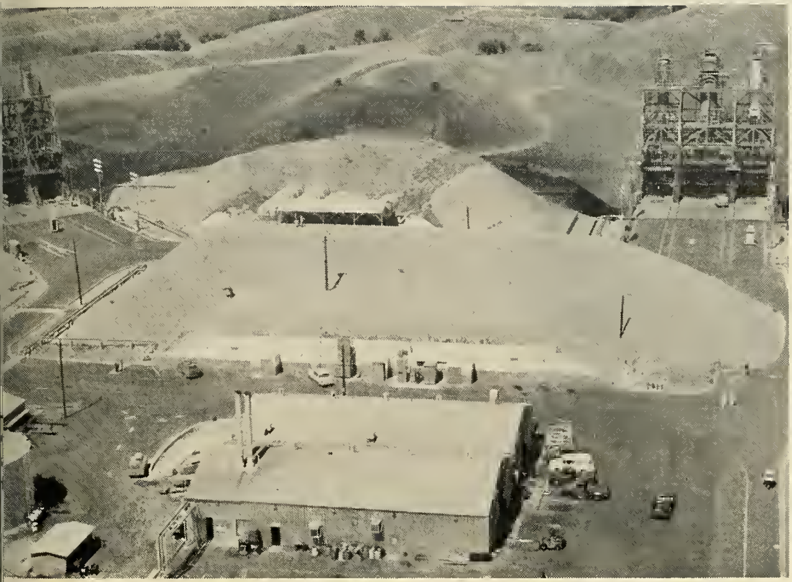
- **Propellant storage and distribution**—The bulk storage and distribution control system is centrally located. The selection of this area was influenced by two factors; it was minimum distance for a single bulk storage facility, and it most nearly complied with quantity-distance regulations established by for the propellants hydrazine, UDMH, and nitrogen tetroxide.

Fuel and oxidizer unloading stations are provided for truck and rail-

About the Author

D. M. (Dan) Tenenbaum directs testing operations for both the Liquid Rocket Plant and the Solid Rocket Plant of Aerojet-General Corporation near Sacramento. An Aerojet employee since 1948, he was responsible for testing of numerous rockets for aircraft programs. He now directs rocket engine testing for the Titan, Polaris, Minuteman and other Aerojet projects.

est Facilities



car deliveries. The unloading operation, as well as the fuel mixing and coordination of transfer to the various test locations, will be controlled from the central control building located within the storage area. Propellant spillage and scrubber effluent are directed to the large concrete-lined water sump equipped with a pH meter to detect excessive concentrations of fuel or oxidizer. Chemicals are added to provide neutralization if the concentration exceeds the normal limit.

The unloading of the tankers, which are pressurized by nitrogen, and the transfer from the storage facility to the test stand tanks, is an operation remotely controlled from the station located in the storage area. It is conducted from a process-type display panel with an override control at the receiving point for use in the event of an abnormality.

• **Fuel mix facility**—Since Aerozine-50 fuel is not supplied in the blended condition, a fuel mixing facility had to be constructed. This facility is located between the fuel unloading station and the fuel storage.

Two stainless steel tanks having capacities of 11,300 gallons (UDMH) and 8800 gallons (hydrazine) are mounted on strain gage load cells. The fuel components are pumped separately but simultaneously from each outlet into an impeller mixer, the output of which is directed to the fuel storage tanks.

Continuous recording of the percent mix is presented at the control station on a potentiometer-type strip chart recorder. In addition, a continuous record is made of the specific gravity of the mix. The percent mix display includes visual limits of mix, as well as off-mix alarm devices. The tank load cell system provides a backup with these system refinements:

a. A check on the overall ratio of the mixed fuels.

b. A record of the delivered propellant weight.

c. A backup in the event of a failure of the conductivity system.

• **Scrubbers**—Scrubbers are provided to minimize the toxicity of the propellant vapors expelled from the test stand run, catch, or storage tanks during any venting operations. Interim scrubbers of the water spray or chemical type have been used.

The operational facility has venturi throat scrubbers typical of those manufactured by the Schutte and Koerting Co. The gases are scrubbed by the action of the liquid spray—a 20% sodium hydroxide solution for oxidizer gases, and water for fuel gases—which creates sufficient suction to entrain the gas and enter the throat of the venturi where the gas and spray are mixed and the gas thoroughly scrubbed.

• **Test stand systems**—For the storable propellants, all bleed and drain systems are closed-loop (i.e., propellants are never intentionally exposed to the atmosphere) or routed into scrubbers. In addition, downward slopes are maintained in all propellant lines to provide for ease of draining and bleeding; propellant outflow from the bleeds and drains is routed into a catch tank for each propellant. All propellant vapors are routed through the scrubbers for each propellant.

Catch or dump tanks are provided for each propellant in each test zone. They have enough capacity to contain the full run tank volume in the event of an emergency that requires rapid evacuation of the propellant run tanks. These tanks are also used as catch tanks for all closed-loop bleeding or draining effluent.

Provisions have also been made to transfer contaminated propellant from these tanks into tank trucks for disposal or refining.

Propellants which have been inadvertently spilled are immediately washed down with copious amounts of water. Concrete drains route the spilled mixture into a large concrete sump equipped with a pH monitoring device. When excessive buildup of a propellant is noted, the sump is chemically treated to neutralize its contents. The deflector residue is also routed into this sump.

Ground water outflow from the plant perimeter is continuously monitored to detect the presence of excessive propellant residue. If excessive buildup is detected, the outflow is directed into retention ponds for chemical treatment.

• **Safety**—Safety of personnel has been a major part of this program from its inception.

Design of the system for safety has naturally been stressed. We have also added emphasis on pre-planning to insure that all employees completely understand the work to be performed, installed a buddy system so that no employee is allowed to work alone on storables, and thoroughly instructed employees on comprehension of safety clothing and the plan for unexpected emergencies.

The current medical history record of a representative group of personnel has shown no adverse effects as a result of their daily work with storables.

FROM LABORATORY CURIOSITY TO MISSILE TRAJECTORY...

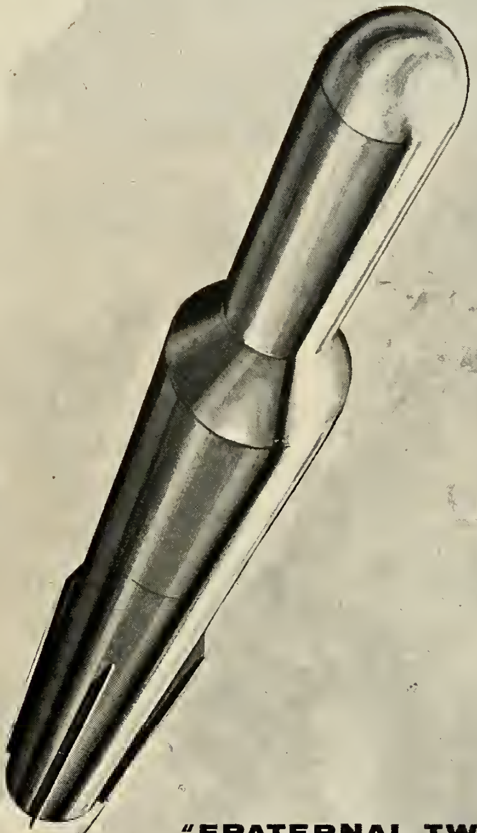
MICROELECTRONIC GRAY MATTER FO

TOMORROW'S air and sea launched ballistic missiles will fulfill a pivotal role in the nation's retaliatory arsenal. Directing their flight will be revolutionary guidance computers, miniaturized to a point far beyond the limit of conventional design techniques.

But before this degree of miniaturization can be achieved in a computer *that must be more than a laboratory curiosity* a radically new design philosophy must be applied.

Engineers at G.E.'s Light Military Electronics Department are meeting the challenges of size and sophistication by pursuing a predominantly *functional* approach to micro-electronics...exploiting the versatility of tunnel diodes and other semiconductors in conjunction with thin film circuit wafers.

And by designing *for* microminiaturization from the start, not only is it feasible to achieve far greater component densities— the development of standardized circuits and functional modules also reduces the numbers of components and connection interfaces, significantly enhancing predicted reliability.



ISSILE GUIDANCE

Electronics engineers with experience and interest in this burgeoning field are invited to write informally for additional technical data or information on specific professional opportunities.

Address inquiries to Mr. R. Bach, Department 73-WJ.

LMED

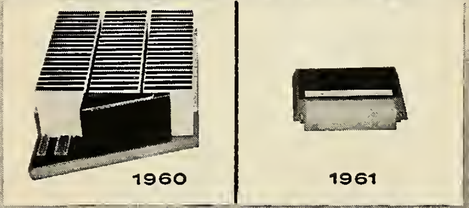
LIGHT MILITARY ELECTRONICS DEPARTMENT

ENERAL ELECTRIC

FRENCH ROAD, UTICA, NEW YORK

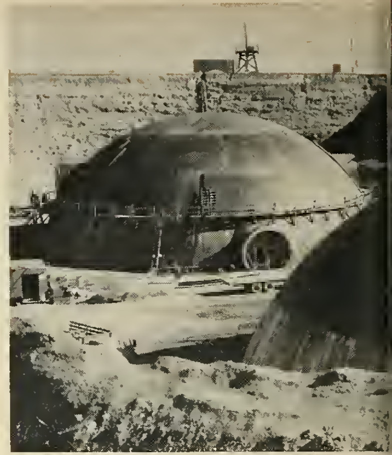
"FRATERNAL TWINS"

The unit at left represents a missile-borne computer developed by Light Military and miniaturized by conventional techniques to near the limit of 1960's state of the art. The 1961 experimental model along side (providing equivalent function) will be designed for microelectronics employing LMED's thin film wafers in modular construction. It is about 1/20th the size of its "fraternal twin."



First Hard Site For Titan I Takes Form

Complex at Lowry due to be operational by mid-1961; designed reaction time less than 15 minutes



FIRST TITAN delivered to Vandenberg AFB, Calif., is used for check-out.

LOWRY AFB, COLO.—A "concrete machine" rapidly taking shape here—the first hard site for *Titan I*—is expected to be ready for operation by a squadron by mid-1961.

Construction on the complex is now at its peak, the Air Force says, and final brick-and-mortar work will take another six months. The remaining site (minus equipment) will house the 703rd Strategic Missile Wing; it is built to withstand a near miss, but not a direct hit.

The Air Force declined to specify what size weapons these estimates were based on, but the structures are designed to withstand a 100 psi overpressure.

Tolerances required of the concrete work in this first site gave rise to the "concrete machine" description. These require a 1/32-in. silo tolerance, in addition to shock-mountings for all other equipment, including stairways, toilets, doors, light fixtures, floors and operational equipment.

The overwhelming size, weight, and depth of the complex make it apparent the Air Force expects to be hit first, but is intent on maintaining the ability to hit back. Everything is designed to maintain a reaction time of less than 15 minutes.

Maintenance will be on a remove-and-replace basis, with no attempt to make any repairs at the site. The Air Force says it is producing birds at a rate which will allow for replacement. Crews will travel periodically to one of the established missile ranges to get experience in actual launches, rather than merely static tests.

Each squadron will have nine missiles, with one extra as a spare. Three missiles will be at each of the three launch complexes in the *Titan I* system, and the *Titan II* system will have only one storable, fueled missile at each site.

• **Direct command**—If war comes, a command to launch the missiles will come directly from the White House to the launch control center without travelling through any of the routine command channels. In event the President and other government leaders are casualties, ". . . an alternate plan will be followed," said a SAC officer.

There will be about five 12-man crews at each complex—about half as many as are considered necessary at a hardened *Atlas* site, the Air Force said. Living quarters are provided underground for crew members. The *Titan* sites are expected to be ready for operation before the hardened *Atlas* sites.

The second floor of the control center in the power house is not attached in any way to the external domes of these units, but is mounted on independent pillars which are attached to spring-beams in the main floor. Under a load, these steel beams flex like an automobile leaf spring. There is a 12-in. "rattle space" between the edges of the second floor and the internal wall of the dome.

Dispersal between sites is about six miles here, although the Air Force says the optimum is 18 miles.

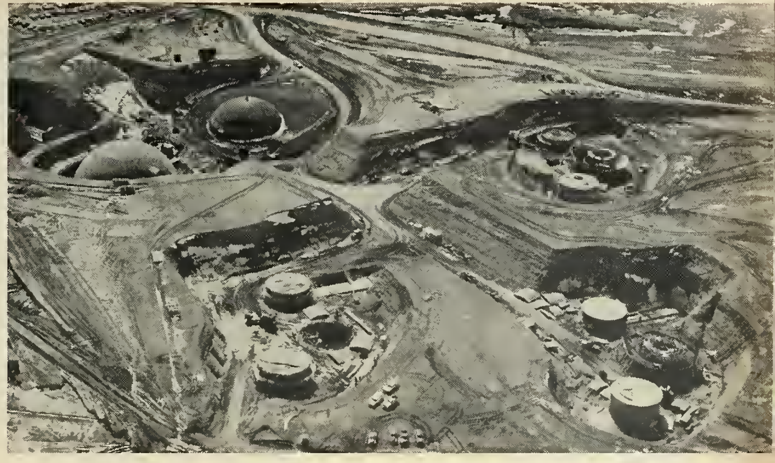
The initial explanation for the discrepancy was that the Air Force reduced the distance in the interest of economy, considering the cost of additional land acquisition. It was later explained that the Lowry complex was planned and begun before the 18-mile figure was established.

This in turn was attributed to increased Soviet nuclear capability.

• **Vulnerability**—Despite the tremendous emphasis on hardened sites and short reaction time, there is an unescapable period of vulnerability which the Air Force hopes to eliminate with all-inertial guidance.

The radio-inertial guidance now used in early models of *Atlas* and *Titan* requires that final velocity and trajec-

LEFT: Underground Powerhouse Dome of typical "hard site" at Lowry (at left) and the Control Center Dome (at right).



RIGHT: In the foreground are three of the launch silos; at top left, the Control Center Dome, nerve center.

tory corrections be radioed to the missile during flight. This will be true of the *Titan I* squadrons.

Two characteristics of the problem are that the correction for *Titan I* does not begin until after second-stage ignition and continues until final vernier burnout, and that radio antennas must be out of silos and above ground.

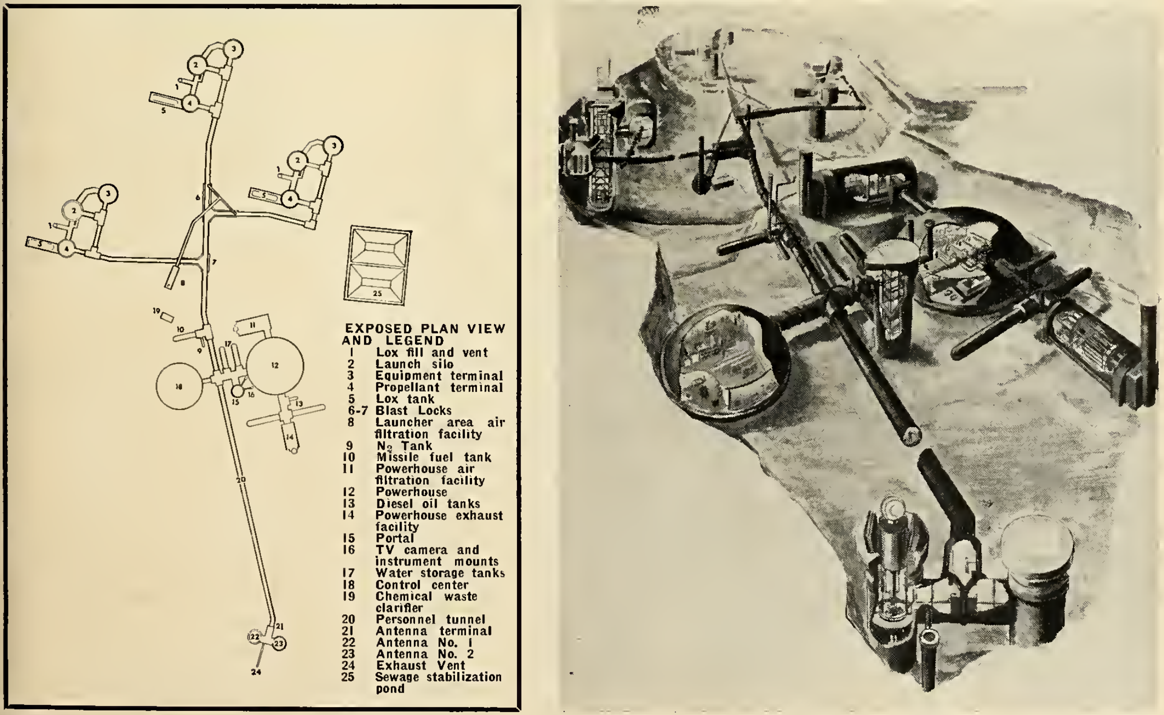
So, despite the short reaction time, *Titan I* is vulnerable for several minutes after launch—a condition which the switch over to all-inertial guidance is expected to correct.

The open-cut excavation containing the concrete and steel domes is about 40 ft. deep; it required removal of 600,000 cubic yards of earth for each of the three sites. Seventeen feet of earth will cover the apex of each dome, and contractors have already begun filling in the excavation, since all external concrete work has been finished.

Each half of the silo doors will weigh 116 tons, comprised of steel reinforced concrete about 36 in. thick.

Total material used in the site construction for the squadron include 200,000 cubic yards of concrete (405,000 tons), 200 tons of six-inch steel beams and 45,000 tons of other steel and metals. The 40-ft.-diameter, 157-foot-deep silo will have hydraulically-operated doors. After these open, an elevator (rate of ascent classified) will raise the missile and its 18-foot-square crib to ground level, with the aid of 240 tons of counterweights.

Simultaneously, the guidance antennas will emerge from 65-ft.-deep silos ready for action. Power for all electronic and electrical equipment in the complex will be supplied by four diesel generators, each producing 1000 kw with overload capacity of 163 kw. The 24 generators used by the two Lowry squadrons will consume 1,589,790 gallons of diesel fuel per month.



TYPICAL TITAN I BASE, with three missiles, shown in a schematic and an artist's conception.

Guidance Designed to be Fail-proof

A look at the radio command system being developed for Titan I and the all-inertial plans for Titan II

by Charles D. LaFond

Without the accurate and reliable guidance being built for the *Titan* ICBM, it would never be more than a simple, 90-ft., 100-ton monster incapable of discrimination.

The *Titan* ICBM is designed for but one task: To deliver a nuclear warhead a distance of 6000 statute miles and impact on a designated target.

If it fails to do this within the statistical accuracy demanded by the Air Force, it will have failed as a deterrent to war and will be ineffectual in retaliation.

Titan guidance is being designed *not* to fail.

To assure early capability, *Titan I* squadrons will employ radio command guidance; *Titan II* squadrons will follow with all-inertial guidance systems.

Radio command has certain weaknesses—such as the need for close grouping to fire in salvo, the need for exposed antennas, and the possibility of jamming. But it does offer early development, high reliability (because of the simplified missileborne equipment), and relative low cost and weight.

With operational squadrons in hand, the time and money to develop the more desirable all-inertial guidance systems can be more wisely spent.

Radio-Inertial Guidance

Employment of radio-inertial guidance in the early *Titan I* squadrons was recommended to the Air Force's Western Development Div., ARDC, by the Guided Missile Research Div. or Ramo-Wooldridge Corp., responsible for systems engineering and technical direction of the *Titan* program. (WDD is now the AF Ballistic Missile Div.; the Ramo division later became Space Technology Laboratories, a nonprofit corporation, and more recently this same functional group became Aerospace Corp.)

Bell Laboratories and Western Electric Co. (WECO) formed the team chosen in 1955 to develop *Titan I* guidance. System development has been directed by Bell Labs at Whippany, N. J. The guidance system is produced by WECO at its North Carolina Works.

TITAN I COMMAND GUIDANCE instrumentation, in upper section of 2nd stage, just aft of warhead, includes radar beacon, autopilot, command receiver and decoder.

The system basically consists of the following:

–In the missile are the autopilot (developed by The Martin Co.) and a command receiver, decoder, and radar beacon or transmitter (all developed by WECO). The missileborne system is located in the second stage just aft of the warhead.

–On the ground are the guidance computer complex (Remington Rand-Univac Div. of Sperry-Rand) and the radar and associated electronics for tracking and command signal transmission (all by WECO). The radar system employs a single antenna for tracking and for transmitting guidance command signals.

Titan guidance radar is based on the *Nike-Hercules* target tracking radar system. Completely redesigned for *Titan* use, the system was made more automatic and maintenance requirements were reduced.

- **Operation**—The ground-based radar continuously determines missile position during powered flight. A digital computer (Remington Rand Athena) accepts this data and refers to previously stored trajectory data for comparison. Correction commands following computation are then transmitted to the missile. These are applied to the missile autopilot and control system.

Six parameters must be controlled during the powered flight: the positions and the velocities along each of three space coordinate axes. To assure correct impact, these parameters must be accurate at the precise moment of thrust termination (forward velocity at this instant is approx. 24,000 ft./sec.).

Radar provides the required position measurements. The three instantaneous-velocity components must be predicted by the ground computer from radar observations. The autopilot system in the bird provides gyro stabilization during the absence of radio guidance control. Highly accurate velocity predictions can be provided within several seconds.

• **Athena is the boss**—The brain behind any of today's command guidance systems is the ground computer center. For *Titan I*, this is the Athena solid-state digital computer. (The original Remington system was built in May, 1951.)

The primary task of the system is to compare actual missile position, furnished by the tracking radar, with the desired position and to issue corrective commands. An equally important control function of the computer is to shut down the second stage engine at precisely the right time.

From the time of initial launch, the Athena's operation is completely automatic.

The system dissipates about 800 watts and utilizes a high-speed magnetic drum storage unit for trajectory information.

Employing more than 100,000 parts, the system nevertheless has chalked up an enviable reliability record—99.89%. This is believed to be considerably higher than minimum AF specifications.

So far, eight Athena computers have experienced a total of 53 failures in a total operating time of nearly 26 thousand hours. Many of these 53 failures would have had no effect on missile performance since they occurred during routine maintenance.

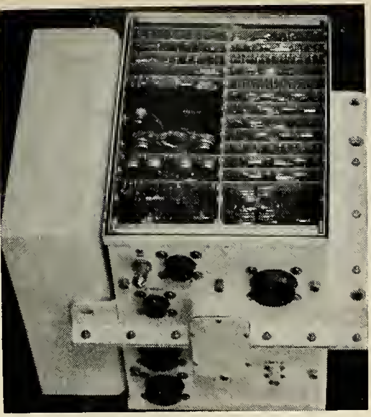
An important feature of the computer circuitry design is that momentary failure or transient error cannot cause permanent change in guidance. Also, to reduce speed (part of the quest for higher reliability and performance), operation is parallel rather than serial. Ample tolerance has been permitted throughout the system design for variations in signal delay due to component aging.

The system is self-checking, but to minimize operator error once the control switch is turned from "Test" to "Guidance" all other controls are disabled.

Maintenance for the system has been greatly simplified by broad use of one simple standard circuit which comprises 75% of the entire computer. Over 3000 of these circuits are used. Functions are varied by their interconnections within subsystems.

Based on the success of several developmental models under test for some time, the Air Force announced in June award of contracts exceeding $26 million to Remington for production and testing of operational-type Athena guidance computers.

• **Flight testing**—With nearly a score of flight tests attempted so far, the command guidance system is considered almost proved and ready for operational use. Advanced flight testing currently in progress probably will result only in slight product improvements. System successes have been numerous not only for *Titan I*, but for other space vehicles.



PCM MONITORING telemetry package (top removed) for Titan II is being developed by Radiation, Inc.

It served as guidance in the *Thor-Able II* Re-entry Test Vehicles and was used to place *Tiros I* in orbit on April 1, 1960. The same system will be used for NASA's second meteorological satellite in October, 1960.

Most recent use was in successfully placing *Echo I* in orbit Aug. 12.

All-Inertial Guidance

The widely sought *Titan II* all-inertial guidance contract finally was awarded to AC Spark Plug Div. of General Motors in April, 1959. The $84-million contract called for the design, development, limited production and testing of a two-package all-inertial system.

AC Spark's task essentially was to develop the Massachusetts Institute of Technology's Skipper inertial platform for *Titan* use. The company's experience in this field was solid, since it has been all-inertial guidance prime for the Air Force *Thor* IRBM with its AChiever system. Also among its many other guidance packages, AC was subcontractor to The Martin Co. for the *Mace* inertial guidance system.

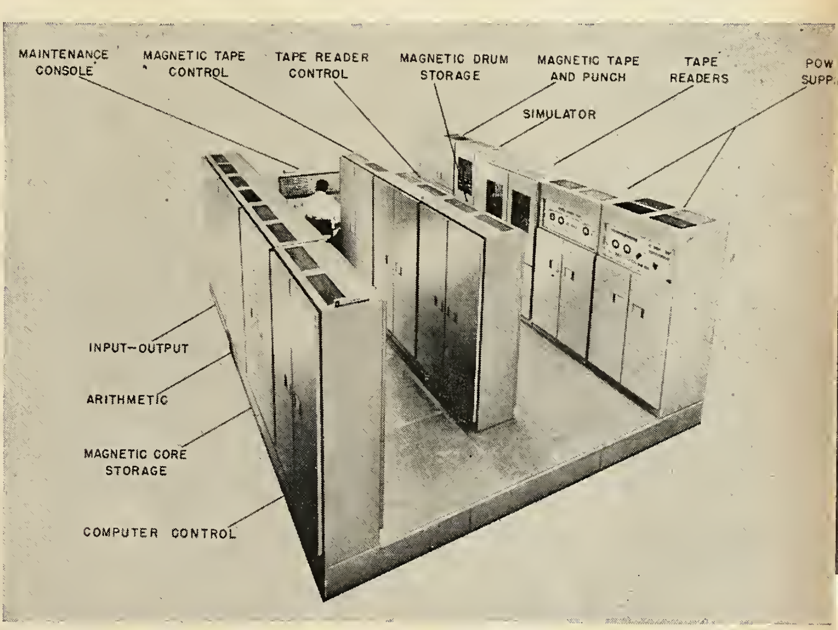
International Business Machines Corp. was selected to develop an advanced solid-state guidance computer for AC Spark.

• **Guidance platform**—The stable platform as developed by AC Spark makes extensive use of the lightweight metals. AC Spark-developed liquid-bearing gyros, for example, are fabricated from beryllium.

Heart of the platform is the three-gyro gimballed stabilization system. An associated system of three accelerometers is used to sense precisely speed and direction change—elevation and azimuth.

How precise is this system? Most of the facts are classified, but it is known that the *Titan II* all-inertial guidance is vastly better than that used in *Thor.* For the *Thor* IRBM, gyros are so sensitive that they sense—and in effect measure—angular velocities as low as 1 revolution in over 10 years.

It has been stated officially that the *Titan* advanced guidance will have to be at least five times more accurate



ATHENA digital computer developed by Remington Rand-Univac for use with Titan I radio-inertial guidance.

than *Thor* guidance just because of its vastly increased range. Actually, its accuracy is believed much better than that.

Size of the new system is believed to be similar to advanced versions of Arma's *Atlas* all-inertial guidance system. (Current *Atlas* guidance is large and is installed in a bulbous pod on the outside of the missile shell. Second- and third-generation subsystems — already in the hardware stage — have been reduced in volume by about 75%.) The AC Spark stable platform alone is reportedly about 1-1/3 cu. ft. in volume.

The system will be located in the *Titan II* second stage. Through the use of a porro prism on the platform, the system must be aligned in azimuth optically prior to launch.

- **Missileborne computer**—Almost no information is available concerning the guidance computer for *Titan II.* But, based on recent advances by IBM in miniaturizing complex computer systems it is certain that the package will be unusually small and lightweight.

The miniature 8-lb. solid-state memory drum recently revealed to the public by the company in Washington is believed to have been developed for *Titan II.*

The actual memory unit is a 6-oz. stainless steel drum having a magnetic film surface. The drum is housed within a 3-in. long by 3-in.-dia. metal frame. The frame holds the magnetic pickup and recording heads which are imbedded in rectangular blocks of plastic, called slider bearings.

The bearings slide over the drum surface, riding on a cushion of air 100-millionths inch thick. Drum capacity, according to IBM, is 100,000 bits of information.

- **First flight in 1961**—Both the inertial platform and the computer package are currently undergoing extensive laboratory test operation.

First flight of the complete system (believed to weigh roughly from 175-200 lbs.) is scheduled for early 1961, probably in the spring.

A PCM (Pulse Code Modulation) telemetry system developed by Radiation, Inc., will be installed during the test flights to monitor the guidance system. The RI system is currently undergoing rocket-sled tests at Holloman AFB, N.M.

Built for AC Spark, the missileborne telemetry features a capability for processing analog information along with bi-level digital inputs and a serial output from a digital computer. It is believed that this capability of telemetering plus digital processing approaches the ideal unitized instrumentation package and is a first in the telemetry field.

- **System components**—The PCM package is a solid-state system weighing less than 19 pounds and occupying approximately 0.36 cu. ft.

It contains a 64-channel analog multiplexer, 41-channel digital multiplexer, programer with word construction units, and an analog-digital converter and power supply. All inputs are multiplexed and programed with synchronization codes onto one serial NRZ (non-return to zero) output through a precision-designed filter which eliminates side-band splattering upon transmitter modulation.

Since the PCM system processes digital information from the guidance computer, it normally will accept a control signal from the computer to develop its basic bit rate frequency and be locked synchronously to the computer.

However, both a frequency and amplitude monitoring of these external signals for accuracy is performed within the PCM system. Should the computer frequency drift beyond acceptable limits the PCM system will no longer accept it as a bit rate control but rather switches over to its own crystal-controlled oscillator. This feature preserves the coding of analog information should the computer become erroneous.

System design of this PCM is such that RI predicts a probability of continuous operation of 0.998 for a 2-hour pre-launch environment and a 6-minute flight without loss of any information.

Underground Communications System

An error-free communications system that hangs underground is being installed in the *Titan* base at Vandenberg AFB. The system employs the first sub-surface switching apparatus in the U.S. missile/space program to launch the two-stage ICBM from an underground silo or hardened site.

Equipment is suspended in caissons below ground to provide a high degree of physical balance in shock waves and pressures generated by possible enemy nuclear attack.

The ITT-Kellogg system is designed for ultrareliability: an order or message must always get through, regardless of momentary situations, interferences, interruptions or human error. Any specific function built into the system is performed as needed, to the exclusion of all others.

The communications system is made up of eight separate operations: administrative communications, operational communications, page and countdown, camera control, fire alarm, operation direct line, maintenance and checkout, voice recording and range safety.

The camera control system provides sequential photographic documentation of each launch for engineering study, analysis and review. As the intense heat of the first firing engines melts the lenses of the cameras nearest the launch site, outlying cameras are automatically switched in to continue documentation.

A documentary record of all commands and instructions during countdown and firing is made by the voice recording system. This system is integrated with the operational direct-line communications systems which provides rapid push-button communications for selected command, operational, certain maintenance, and checkout activities.

The public address and alerting system provides emergency communication to the various operational, administrative and maintenance areas. This system is tied in with the telephone switchboard to permit telephone handsets to be used as microphones to broadcast messages over the p-a system.

The dial telephone system—which handles the communications for administrative functions of the complex—serves as an emergency communication facility for the command and operating activities should direct line capability be disrupted.

An executive-right-of-way feature permits high-priority telephones to over-ride a conversation on a dial telephone or a message broadcast over the p-a system from a telephone line.

Cubic to Modernize NOTS Missile Tracking Gear

Modernization of data processing and missile tracking equipment at the Naval Ordnance Test Station, China Lake, Calif., will be done by Cubic Corp.

Primary task in the 6-month program will be the addition of equipment for use with Cubic's MIDAS (Missile Intercept Data Acquisition System). Both a new data digitalizing system and a remote control capability for digital-to-analog conversion equipment will be installed.

MIDAS is used to track missile during operational and evaluation firings and can track simultaneously any two of four possible targets.

The new equipment is expected to speed up significantly the processing of missile performance data. Tracking information following initial processing will be recorded on magnetic tape and then fed into a computer.

Support Equipment Highly Integrated

Novel approach for operational Titan marries subsystems to ground control, checkout and simulation

by Hal Gettings

Support equipment for the operational *Titan* has two unique features: integrated launch control and checkout, and a novel systems approach between airborne subsystems and associated test equipment.

Martin Co.—*Titan* "associate prime"—divides the support equipment into GOE (ground operating equipment) and mechanical handling and associated hardware. GOE is primarily electronic and electrical, although hydraulic, air-conditioning, and missile release systems are included.

Titan GOE is a fully integrated launch control and checkout system made up of several subsystems interconnected with each other, with the missile, and with other facilities. It includes all equipment needed to control, monitor and check out the missile, as well as the operating components of the propellant loading system, associated equipment, and facilities.

Contractors for major subsystems—nose cone, guidance, communications, propulsion—design and build checkout equipment for their particular system. The various checkout hardware is then integrated into the overall GOE system.

According to Martin, such a procedure has definite advantages. Test equipment is built by the company most familiar with the system to be tested, yet the various pieces still fit together to form an integrated whole.

The GOE has three operating modes: launch, captive-firing, and checkout.

The launch mode is manually initiated by a switch-indicator on the launch complex control console. Control of the launch firing sequence is automatic, using timed or events-actuated signals. Should a malfunction occur during the launch mode, it is detected, isolated and indicated to the subsystem level of the missile or the GOE.

The captive-firing mode is initiated at the launch sequencer set and controlled in the same manner as the launch firing phase. The launch sequencer provides for a timed firing and automatic-shutdown initiation.

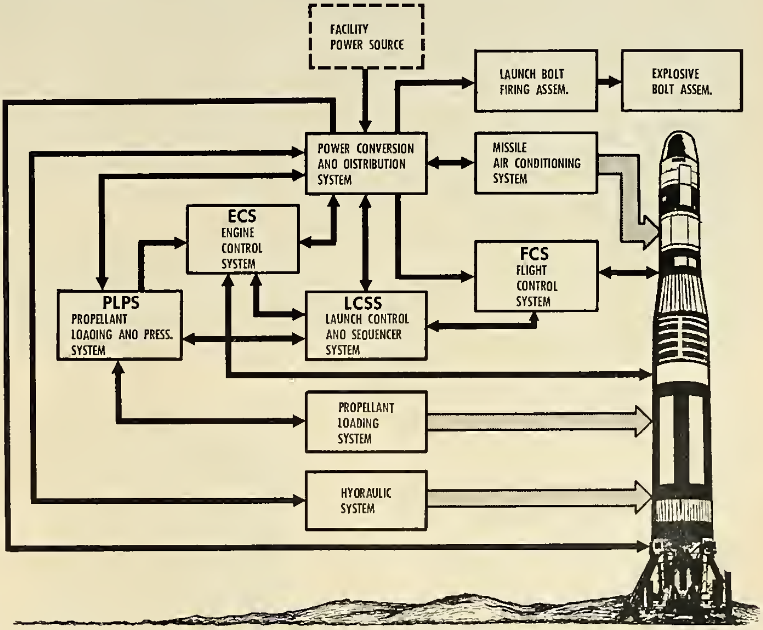

FACILITY POWER SOURCE
LAUNCH BOLT FIRING ASSEM.
EXPLOSIVE BOLT ASSEM.
POWER CONVERSION AND DISTRIBUTION SYSTEM
MISSILE AIR CONDITIONING SYSTEM
ECS ENGINE CONTROL SYSTEM
FCS FLIGHT CONTROL SYSTEM
PLPS PROPELLANT LOADING AND PRESS. SYSTEM
LCSS LAUNCH CONTROL AND SEQUENCER SYSTEM
PROPELLANT LOADING SYSTEM
HYDRAULIC SYSTEM

DIAGRAM SHOWS interrelationships between subsystems of the Titan I launch control and checkout system. Support equipment for Titan II will be somewhat simpler.

The checkout mode controls the post-installation and prefiring test of the missile, its associated facilities and the GOE. In this mode, the GOE permits evaluation of the functional status of the components of each subsystem, and isolates malfunctions by individual chassis or missile components. Malfunctions are isolated to the chassis level in the GOE and to the replaceable component of the missile.

- **Power conversion and distribution system (PCDS)**—The PCDS provides and controls power conversion, distribution, and monitoring within the launch complex. The system consists of a power switchboard, power supply units, and an accessory supply system.

The power switchboard distributes primary electric power to motor and subfeeder circuits.

A 28-volt dc supply starts and runs the missile accessory supply inverter during the launch operation until transfer to the missile battery. A second power supply furnishes nominal 28-volt dc power to the missile busses—until transfer to the missile battery in the launch mode—and to the launch control and checkout equipment for any mode of operation.

A battery power supply furnishes standby or emergency power for the missile and ground operating equipment to insure a safe shutdown should the primary or 28-volt dc supply fail.

A motor-generator provides 400-cycle, 120/208 volt ac power for the missile and GOE. The accessory supply system provides electrical apparatus for the control, distribution, and monitoring of electrical and hydraulic power to other ground operating equipment and missile equipment during ground operations.

- **Launch control and sequencer system (LCSS)**—This system provides initiation, actuation, and monitoring of missile launching, captive firing or shutdown functions. It consists of launch sequencer set, launch complex control console and time display board.

Titan Operational Checkout and Launch Equipment Units

Systems Equipment Required	Number of Chassis	Remarks
LAUNCH CONSOLE	(one unit)	Single operator required; one or more missiles launchable from one unit. Voice communications inside and outside blockhouse.
EQUIPMENT AND FACILITY CONSOLE	(one unit)	One operator required; monitors checkout of entire launch complex; control retained during readiness periods and launch.
EQUIPMENT PALLETS		
Accessory supply system	8	Serves as both launch control and checkout equipment.
Flight control system	7	" "
Propellant loading and pressurization	11	" "
Engine control	6	" "
Re-entry vehicle	6	" "
Airborne guidance	8	" "
Launch sequencer	4	" "
Control center	2 (per missile)	" "

The launch sequencer set generates the commands and performs the logic necessary for controlling and monitoring launch and status functions. The launch complex control console controls and monitors major events of a launch sequence and indicates the status of the equipment and facility.

The time display board provides timing information for launch or captive firing operations. It consists of a 24-hour clock displaying local or Greenwich time, and a 4-hour countdown timer clock indicating remaining countdown time in hours and minutes during the manual portion of the countdown sequence. An automatic countdown timer clock for the last portions of countdown indicates remaining time in seconds, as well as time after firing until liftoff or shutdown.

- **Propellant loading and pressurization systems (PLPS)**—The propellant system delivers propellants and gases to the missile propellant tanks. It also initiates and controls pressurization of the missile pneumatic system and missile propellant tanks, initiates disconnect of the propellant umbilical and tank vent connector, provides nitrogen for starting engines, and performs checkout functions.

The PLPS uses a unique method to fuel an operational missile at the fastest rate possible. When loading starts, a low-level sensor indicates that fuel is coming aboard. No further measure is made until the topping-off phase—which must be indicated with very high precision. Then the tanks are overfilled, the system pressurized, and tanks drained down to proper level.

Although fueling times are classified, Martin says that the *Titan* system gives a very fast and satisfactory fill rate.

- **Flight control system (FCS)**—The FCS checks out and prepares the missile flight control system for launching and flight. It consists of a flight control set and a targeting command chassis. The flight control set generates the commands and performs the logic necessary for controlling and monitoring the checkout and preparation of the missile flight control system for launching and flight. The targeting command chassis provides flight program setting signals to the flight controls set.

- **Engine control system (ECS)**—The engine control system prepares the first-stage engines for firing and initiates the firing. It also monitors engine parameters essential to safe and successful engine operation.

- **Missile air-conditioning system (MACS)**—MACS provides conditioned air for the second-stage compartments. Air is drawn through an intake opening, cooled and delivered through two discharge openings to pipes which direct it to the missile skin.

- **Hydraulic system**—The GOE hydraulic system is a pumping unit which pressurizes the missile first-stage hydraulic system.

- **Missile release system**—This system releases the missile for flight by detonating explosive tie-down bolts when the first-stage engine attains predetermined thrust. It consists of a launch-bolt firing assembly and an explosive bolt assembly.

The launch bolt firing assembly, upon receipt of signals from the accessory supply system, furnishes power to the explosive bolt assembly to detonate the bolts. The explosive-bolt assemblies restrain the missile at four points until the first-stage engine has reached its proper thrust level; then the four bolts are exploded and the missile released for launch.

Titan II—The advanced all-inertial ICBM—will use basically the same GOE system, modified to fit new equipment. A major difference will be in simplification brought about by storable propellant and inertial guidance and the consequent simpler countdown and checkout procedures.

MOC Spells Big R&D Savings

DENVER—*Titan's* automated countdown system is credited with saving months of time, several vehicles, and millions of dollars thus far in the R&D phase of the ICBM program. The system, called Master Operational Controller (MOC) links eight racks of equipment and two consoles for preprograming, monitoring, operation and control of all major functions of test and launch procedures.

The MOC checks out the vehicle itself, as well as the test devices, telemetry, transmitters and other R&D equipments that go along for the ride.

Heart of the system is the automatic sequencer, a four-rack unit located in the control building. At preprogramed times during a countdown, this sequencer initiates function control circuits providing power to the other MOC circuits at specified time intervals, and also activates hold-fire circuits at necessary times.

Approximately 120 function-control and 80 hold-fire circuits can be programed during the countdown.

- **Restraint**—During its launch sequence, the *Titan* is held to the launch pad briefly—usually from three to six seconds—until the MOC missile release system has ascertained that sufficient thrust for flight has been achieved. Explosive bolts are attached about the base to carry out restraining action.

The release system can also be operated manually from the test conductor's console. This unit supplies the signal for engine ignition prior to liftoff.

At a preset time, the automatic sequencer provides function control circuit signals to energize the holddown explosive bolts and to check the holdfire circuits which would stop the launch in event of any malfunction between engine ignition and actual liftoff.

The launching can be stopped by any hold circuit—even though the order to launch has been transmitted—up until the time the last umbilical connector drops away from the vehicle.

This system proved its worth very early in the flight-test program by stopping a launch after the engines had been started. The vehicle involved, which would have been destroyed by a malfunction if the original launch had not been stopped by the MOC, later flew on a completely successful mission.

Designed to contribute to the reliability of each launch, the MOC has eliminated the necessity for many human actions and snap judgments.

The automatic sequencer has the ability to check itself out prior to a test, to insure that the sequence of functions is as desired.

A simpler and more compact MOC has been designed for the operational version; further modifications will be made for the *Titan II* follow-on missile.

Besides the automatic sequencer with its four racks of equipment, the MOC setup includes four other racks which control the umbilical, water, missile release, and erector systems.

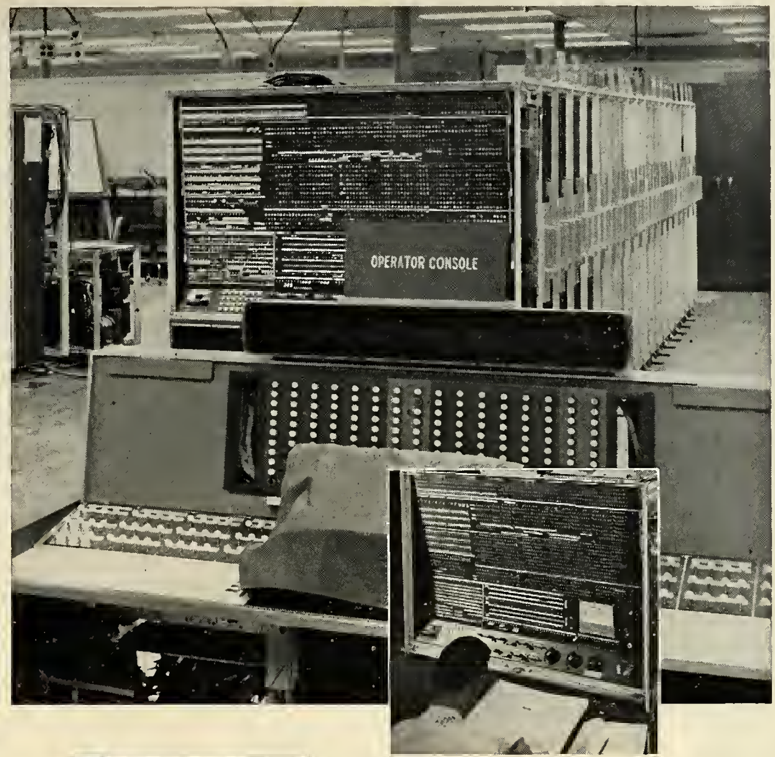
• **Spots troubles**—In addition to carrying out the countdown, MOC can act as a troubleshooter to pinpoint malfunctions during a hold period. Pen recorders monitor the functions being carried out and plot the curves against a ten-per-second time-pip operation, which aids in determining time and location of the cause of a hold in the countdown.

Aside from the final countdown operation, MOC has the capability of checking any subsystem of the missile prior to a test, in order to verify its proper operation. The subsystem, or combination of subsystems, being thus tested are run through the complete gamut of their required operation and the results are recorded.

Not only can the automatic sequencer and its accessory systems call a hold in the countdown, but operating personnel on the launch pad can initiate a manual hold should any situation require such action.

Martin-Denver points out that the MOC is not a thinking device. It will do what it is told to do—and no more. If the countdown steps are programed into MOC incorrectly, they will be carried out incorrectly.

Two hundred functions can be programed into the system.



STRETCH, the world's fastest and most versatile computer, will soon be added to the array of research tools at Los Alamos Scientific Laboratory. This multi-million dollar machine, built by IBM, is 50 to 75 times faster than the IBM 704.

STRETCH can complete more than 75 billion arithmetic operations a day. The system can execute as many as 2 million instructions per second.

A "look ahead" device anticipates instructions and data requirements, thus increasing the effective memory speed to make use of the enormous speed of the arithmetic units.

For employment information write:
Personnel Director Division 60-84

los alamos
scientific laboratory
OF THE UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO

Circle No. 9 on Subscriber Service Card.

a new concept for ordnance safety in missiles and space vehicles . . .

LIBRASCOPE
EBW
EXPLODING BRIDGEWIRE SYSTEM

- Rocket Motor Initiation
- Thrust Termination
- Stage Separation
- Destruct Units
- Replacement of squib or detonator for any ordnance application

Unprecedented safety during the entire stockpile-to-target sequence characterizes Librascope's EBW System for ordnance initiation.

Aboard the vehicle, EBW's virtual immunity to premature initiation makes it possible to eliminate elaborate safing mechanisms. Weight of multi-stage missiles and space vehicles can thus be significantly reduced.

Of prime economic importance is the versatility of the Librascope EBW System. For one EBW flight firing unit will properly sequence and initiate all ordnance components in a complete missile system.

Designed and developed by Librascope's Sunnyvale Branch, the EBW System utilizes the energy produced by the exploding wire to directly initiate an insensitive secondary explosive. EBW initiators of this type cannot be initiated by stray DC potentials or high-energy RF fields.

Send for EBW Brochure to Librascope Sunnyvale Branch, 670 Arques Ave., Sunnyvale, Calif.

LIBRASCOPE DIVISION
GENERAL PRECISION, INC.

Circle No. 10 on Subscriber Service Card.

Major Titan Subcontractors and Suppliers

COMPANY	ADDRESS	ITEMS SUPPLIED
ACF Industries	Buffalo, N.Y.	Aluminum spheres
Aerojet-General Corp.	Azusa, Calif.	Fittings, LOX compound
AiResearch Mfg. Co.	Phoenix, Ariz.	Regulator for pressurization system 2nd stage ven relief valves
Amphenol Electronics Corp.	Chicago	Electrical connectors, connector programing board
Amphenol Electronics	Los Angeles	Electrical connectors
Annin Co.	Los Angeles	Hydraulic valves
Baldwin-Lima-Hamilton	Waltham, Mass.	Thrust mount system
Bendix Corp.	Pacific Div. North Hollywood, Calif.	Relief valves, accumulators hydraulic valves
Bogue Electric Mfg. Co.	Paterson, N.J.	High-level sensor system
Cadillac Gage Co.	Detroit	Servo actuator
Cannon Electric Co.	Los Angeles	Connectors
Consolidated Electrodynamics	Pasadena, Calif.	High-level sensor system probes, transducers, elect equipment, special wire
Cook Electric Co.	Denver	Switches
Dunbar Kapple, Inc.	Batavia, Ill.	Flexible hosing, line assembly bellows
Electro-Mechanical Research, Inc.	Sarasota, Fla.	Telemetry package
Futurecraft Corp.	El Monte, Calif.	Shutoff and hydraulic valves
General Electric	Chicago	Tubes
General Electric	West Lynn, Mass.	Electrical products
General Electric	Skokie, Ill.	Circuit breaker relays
General Electric	Denver	Meters, motors, etc.
General Electric	Denver	Blanket load cell, temp. control lamp
G. M. Giannini & Co.	Pasadena, Calif.	Rate gyro system, transducers, probes
Grand Central Rocket Co.	Redlands, Calif.	Staging rockets
Gulton Industries, Inc.	Metuchen, N.J.	Amplifier, airborne filter, low-pass transducer accelerometer, transducers
Hallamore Electronics Co.	Anaheim, Calif.	Closed circuit TV equipment
Harvey Aluminum	Torrance, Calif.	Plate, sheet and extrusions
Hewlett-Packard Co.	Palo Alto, Calif.	Oscillators, counters, etc.
Kaiser Steel Corp.	Los Angeles	Steel fabrication
Leach Relay	Los Angeles	Relays
Minneapolis-Honeywell Regulator Co.	Aero Div. Minneapolis	Three-axis reference system control testers
Minneapolis-Honeywell	Philadelphia	G-load simulator
Minneapolis-Honeywell	Hopkins, Minn.	Electronics
Minneapolis-Honeywell	Denver	Galvanometer, oscillograph, Muller bridge
Moog Valve Co., Inc.	E. Aurora, N.Y.	Hydraulic valves, servo actuators
New York Brake Co.	Watertown, N.Y.	Hydraulic pump
On Mark Couplings	Los Angeles	Quick disconnects, helium lines
Parker Aircraft Co.	Los Angeles	Check valves, hydraulic fittings
Potter Aeronautical Co.	Union, N.J.	Transducer, flowmeter
Rheem Mfg. Co.	Electronics Div. Rivera, Calif.	Signal conditioner equipment
Rheem Mfg. Co.	Downey, Calif.	Aircraft sheet metal, general machining, elect. instruments
Robertshaw-Fulton Controls Co.	Anaheim, Calif.	Quick disconnects, LOX and fuel all sizes, and regulators for pressurization systems 1st-stage; low-level sensors, frequency converter, hydraulic valves
Scintilla Div.	Bendix Corp. Sidney, N.Y.	Electrical connectors, wiring assemblies
Trans-Sonics, Inc.	Lexington, Mass.	Transducers
Westinghouse Electric Corp.	Baltimore, Md.	Electronics components

—expansions—

NASA's George C. Marshall Space Flight Center has leased 96,720 sq. ft. from Brown Engineering Co. in the Huntsville Industrial Center complex. The contract becomes effective on Oct. 1 when 164 employees will move in.

LITTON SYSTEMS INC. officially opened its 180,000-sq.-ft. Computer Systems Laboratory on a 63-acre site at Woodland Hills, Calif. Manufacturing buildings, offices and other structures eventually will be built at the site, bringing the total to 750,000 sq. ft.

LOCKHEED'S Marietta, Ga., division is creating an aerospace design department in its engineering branch. Dr. H. S. Sweet will manage the department, which will work on preliminary design and related fields.

ATLAS CONTROLS, INC., designers and manufacturers of regulated power supplies, some used in Martin missiles, moves to a 12,000-sq.-ft. facility in Natick, Mass.

AMERICAN INTERNATIONAL ALUMINUM has opened a new automated and fully integrated aluminum extrusion plant in San Jose, Calif. The 50,000-sq.-ft. plant will extrude aluminum on a Youngstown Foundry and Machinery double entry press.

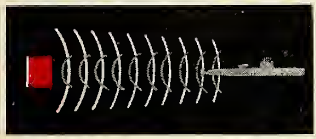
financial

Kaiser Industries Corp.—Second quarter earnings were $2.2 million, bringing six months earnings to $3.5 million. First half earnings reflect lower profits of Willys Motors, Inc., a wholly-owned subsidiary; elimination of the dividend on Kaiser Steel Corp. common stock; elimination of credit arising under an agreement relating to the filing of a consolidated federal tax return, such credit in the first half of 959 amounting to $874,000.

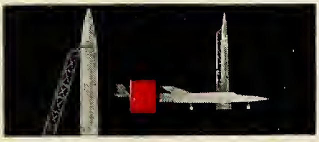
Bourns, Inc.—Net sales reached 5.3 million, with earnings of $341,410 for the first six months. These totals represented a 19% jump in sales over 959, with earnings not compared because of a change in accounting procedure. Backlog at June 30, 1959, stood at $1.3 million; current backlog is $1.8 million.

Victoreen Instrument—Victoreen nearly doubled its 1959 first-half total with net sales of $6 million. Profits rose to $260,770, compared to $219,465 in the previous year's first period.

NEW FROM WESTINGHOUSE: STATIC POWER SUPPLIES FOR SPACE AGE PROJECTS



for Sonar



for G.S.E.

for Radar

for Aircraft/Missiles

Westinghouse delivers rugged, reliable static power in any power range to meet your system requirement. High efficiencies of semi-conductors assure increased system performance. Name your static power conversion problem. Military or commercial? High Voltage or Low Voltage? 1 kw or 10,000 kw? Whatever the application, check first with your local Westinghouse sales engineer. Or write: Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa. *You can be sure . . . if it's Westinghouse.*

J-92501

Westinghouse

Circle No. 11 on Subscriber Service Card.

Details of Norway's ASW Terne

Packaged antisub missile system to be bought by U.S. Navy can be put aboard ships as small as 500 tons

by Bernard Poirier

Kongsberg Vapenfabrikk, the company which won fame by producing high-accuracy whaling harpoon guns, has now developed a packaged antisubmarine missile system for use on small naval vessels.

The *Terne* went through rigorous sea trials before it was declared operational by Norway. The first photo of the ASW missile was published exclusively by M/R at the time the Navy announced the U.S. would purchase the weapon (M/R, July 18).

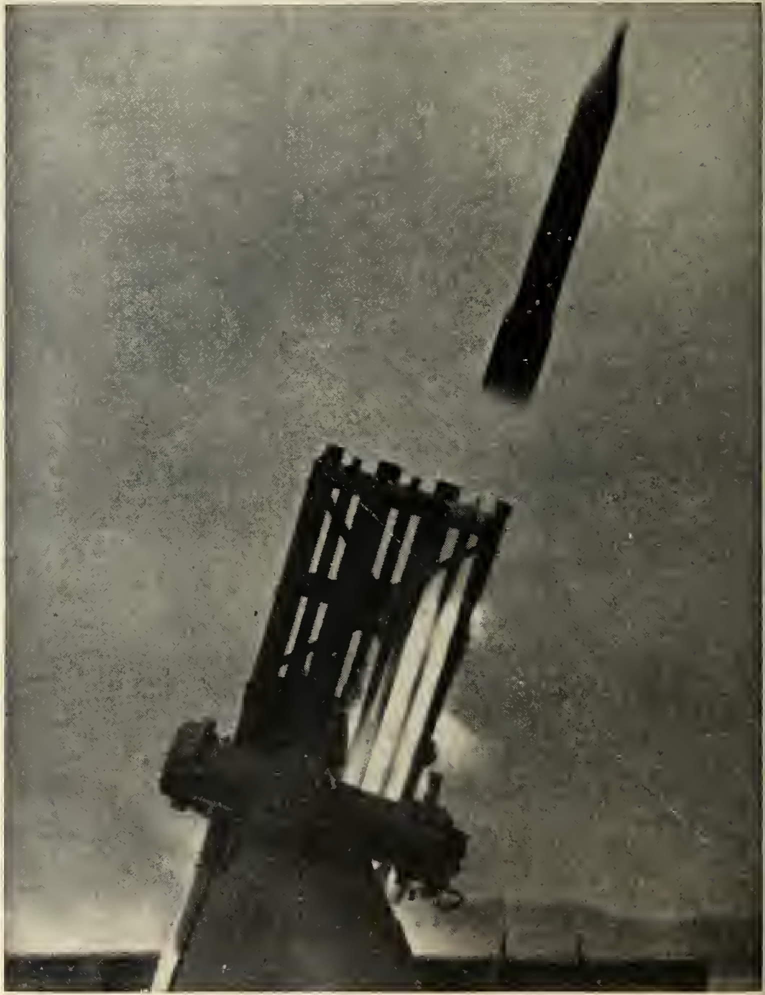
The missile is 6 ft. 5½ in. long and has a 7.9-in. diameter. The newest warhead—the MK 7 depth charge—weighs 105.6 lbs., which is more than one-third the total 264-lb. launching weight. This appears to be an unusually advantageous warhead-weight ratio—which might explain its value to other nations.

• **Sonar mounted beneath hull**—*Terne* can use a built-in selector for a time fuze or a proximity fuze which can be activated at the last second before launching. Special antisubmarine ships as small as 500 tons can have complete "*Terne* capability," according to a spokesman for the Norwegian defense firm. Full capability includes several full salvo loads of six missiles each, a 3400-lb. launcher, and 11.5 tons of electronics.

The transducers of the two sonar systems are stabilized in azimuth and mounted in a streamlined retractable dome with a rubber-covered, sound-transparent window. The window is reinforced with a steel grill and can withstand speeds up to 26 knots. Normal searching speed is 21-23 knots.

The sonar dome is mounted below the hull near the forward section of the vessel. The search sonar works on a low frequency of 11 Kc. and has a range of three miles. It is sensitive enough to detect a torpedo as well as a submarine.

• **Six operators zero in**—The attack sonar operates on a frequency of 30 Kc. and coordinates findings with the search sonar once the enemy submarine is within 3000 yds. The split beam principle is used for location in the vertical and the horizontal planes with a tolerance of about 1%.



EXPERIMENTAL FIRING of Terne ASW missile from a warship at the entrance of a Norwegian fjord during extensive sea trials. An exclusive M/R photograph.

Additional tracking is provided for range and bearing. An electronic vernier range scale with cathode-ray presentation is used to increase range accuracy.

The sonar readings are refined by operators before the information is cranked into the computer. Three operators for each of the sonar systems are located in the ASW control room.

• **U.S. provided assistance**—The Fire Control determines target bearing, range, depth and the ship's own course and speed. These and other variables such as wind speed and direction are fed to the computer, which relates the data to the program. One of the last factors is the actual temperature of the *Terne's* solid fuel when it is in firing position on the deck launcher.

The computer determines the autoatic setting for launcher elevation and earing. At this point the system is tabilized for roll up to 20° and pitch p to 5°.

Upon ignition, the *Terne* develops 1,700 lbs. deck thrust. Within ¾ sec., nother missile can follow. Six missiles an be fired in 5 secs. An additional ll salvo load can be placed in the uncher in ¾ minute.

The *Terne* missile system was developed by Kongsberg in conjunction ith the Norwegian Defense Research stablishment and the Royal Nor-egian Navy. Other assistance was pro-ided by the United States Mutual eapons Development Program.

Kongsberg is manufacturing various omponents for the NATO *Sidewinder* roduction program, whose prime con-actor is Bodenseewerk Perkin-Elmer mbH of Germany. The third top issile in Kongsberg's repertoire is the *S-11* antitank missile, produced for e Royal Norwegian Army by agree-ent with Nord-Aviation, S.A. of rance.

.S. To Pay Building Cost f Aussie Tracking Site

The United States will pay the full b for constructing Project *Mercury* acking stations in Australia, the Aus-alian Minister for Supply has an-ounced.

The States will also meet nearly l costs of operation, including man-ng of the stations by Australians.

Two new posts were being estab-hed by the Americans near Woo-era, he said. One was at Redlake, out four miles from Woomera, for *ercury*, and the other at Island La-on for a deep space tracking station. n 85 ft. dish radar is going up at land Lagoon, with technical and mess ildings to follow.

By agreement with the U.S., a initrack station, operating since 1957, ould be moved from Woomera to land Lagoon.

hird BMEWS Station eing Built in Yorkshire

The third link in the Ballistic Mis-e Early Warning Systems (BMEWS) now under construction in Yorkshire, gland. The other two bases are at ule, Greenland, and Clear, Alaska.

The Yorkshire site at Fylingdales oor, is being built under the joint pervision of the U.S. Air Force and yal Air Force, with RCA Great itain, Ltd. as system contractor. Cost s been estimated at $115 million.

The installation will have three cking radars, each 84 ft. in diame-, enclosed in a 140-ft.-diameter plas- dome.

NEW
FROM
WESTINGHOUSE:

STATIC
POWER
SUPPLIES
FOR
RADAR

Large static radar power supplies for d-c output call for regulated high power, high voltage. Westinghouse delivers it. Positively precise. Typical equipment now furnished by Westinghouse includes switchgear, voltage regulator, rectifier, resistor and capacitor assemblies, and associated controls. Unlimited power ratings can be delivered. Units rated 1,000 kw are currently available. Before a spec is written, consult Westinghouse. Rectifier assembly opposite is part of power package supplied for BMEWS. For help in solving your static power supply problems, contact your local Westinghouse sales engineer. Or write: Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa.

J-92502

Westinghouse

Circle No. 12 on Subscriber Service Card.

names in the news

NOLKE

CROMPTON

ELMS

HERRMAN

WARREN

Fred H. Nolke: Former chief engineer for the Midwest Operating Group of General Telephone & Electronics Corp., joins Page Communications Engineers, Inc. as assistant director of the Telecommunication Directorate.

Dr. Charles E. Crompton: Named director of the Advanced Development Section in the Isotopic Power Department of The Martin Co.'s Nuclear Division.

James C. Elms: Joins the Aeronutronic Division of Ford Motor Co. as general operations manager of Electronic Systems Operations. Was formerly executive vice president of Crosley Division of Avco Corp., and prior to that with The Martin Co.'s Denver Division as manager of the Avionics Dept., responsible for engineering, design, and development of guidance, flight control and other electronic systems for the *Titan*.

William H. Herrman: Joins Stromberg-Carlson's Electronics Division as manager of advertising and sales promotion. Was formerly director of advertising and public relations for the Hoffman Laboratories Division of Hoffman Electronics Corp.

Francis A. Warren: Joins Rocketdyne's Solid Propulsion Operations as senior technicial specialist to **Dr. E. F. Fiock,** chief of propellant research. Previous posts: Manager of the propellant section, Southwest Research Institute; head of the Internal Ballistics Branch, U.S. Naval Ordnance Test Station; and research engineer at Battelle Memorial Institute.

Robert H. Davis: Named chief engineer of Motorola Inc.'s Microwave Dept., responsible for product development, systems engineering and field engineering.

Frank P. Brennan: Joins Metal Control Laboratories, Inc., as director of technical sales. Was previously assistant sales manager of United States Testing Co., Inc.

P. C. Swan: Elected field station manager for the Douglas Aircraft Co.'s *Nike-Zeus* missile testing operations on Kwajalein Island. He is a 24-year veteran with the firm.

Martin R. Amsler and **C. Wesley Michaels:** Appointed manager of marketing, Surface Communications Division, Defense Electronics Products and manager, planning and market research, for Industrial Electronic Products, respectively, with RCA. Amsler was previously manager of marketing administration and Michaels was with the General Electric Co. prior to joining RCA.

Jack B. Lindsey: Former assistant to the president named marketing manager of Microdot Inc.

John W. Allen: Appointed manager, engineering, Non-destructive Testing, Instruments Division of The Budd Co. Was formerly with The Atomic Energy Commission's Oak Ridge National Laboratory, where he was in charge of the Non-destructive Testing Laboratory of the Metallurgy Division.

Irving Rutstein: Formerly with the Missile Systems Division of Republic Aviation Corp., appointed engineering manager of Loral Electronics Corp.'s Countermeasures Division.

Dr. John Mason: Chief of preliminary design for The Garrett Corp.'s AiResearch Mfg. Co., appointed to the Research Advisory Committee on Nuclear Energy Systems, National Aeronautics and Space Administration.

George N. Mangurian: Director of the Technical section of Northrop Corp.'s Norair Division, appointed to the Research Advisory Committee on Aircraft Structures, National Aeronautics and Space Administration.

John F. Moore: Appointed manager of the Product Development Dept., Information Technology Division of Lockheed Electronics Co. Was formerly director of research and engineering at the ASCOP division of Electro-Mechanical Research, prior to that was engaged in design of microwave and tropospheric scatter systems as Communications Group leader for Hycon Eastern, Inc.

Ted Dunnegan, Jr.: Named acting division manager of the Electronics Division of Temco Electronics & Missiles Co., subsidiary of Ling-Temco Electronics, Inc. He succeeds **A. R. Teasdale,** now with The Martin Co.

Cmdr. Samuel A. Forter (USN-ret
Elected assistant director of Massach
setts Institute of Technology's Instrume
tation Laboratory.

Dr. Harold M. Sonnichsen: Joi
W. R. Grace & Co.'s Dewey and Aln
Chemical Division as director of fiber a
saturant research in the Polyfibron di
sion. Was formerly vice president and r
search director of the Permacel Divisi
of Johnson and Johnson.

Albert E. Keleher, Jr.: Joins Labor
tory for Electronics, Inc. as director
Systems Marketing Division. Prior
joining the firm he was manager
marketing planning for Raytheon Co
Equipment Division.

Marion E. Hines: Joins Microwa
Associates in the newly created positi
of senior scientist. Was previously ass
ciated with Bell Telephone Laboratori
Inc.

Kenneth E. Hunter: Former manag
of Special Equipment for Hycon M
Co., appointed vice president of engine
ing.

H. R. Dettwyler: Appointed chief en
neer of the Cooper Development Divisi
of The Marquardt Corp. Was forme
supervisor of the flight test section of t
firm's Propulsion Division.

Gerhard Schilling: Former chief of t
lunar and planetary sciences programs
NASA, joins The Rand Corp.'s Engine
ing Division as a member of the Planeta
Sciences Group where he will conduct
search on problems of space explorati

James W. Noland: Former manag
manufacturing, appointed general mana
of Young Spring and Wire Corp.'s Gon
Division.

William L. Hill: Elected manager
The Martin Co.'s Huntsville office, s
ceeding **G. J. Rauschenbach,** who has
signed. Hill was formerly assistant m
ager and previously participated in
Titan program at Denver.

Edward J. Gately, Jr.: Named m
ager of Clifton Precision Products C
Inc.'s Systems Division.

reviews

UCLEAR FLIGHT, edited by Lt. Colonel enneth F. Gantz, USAF. Duell, Sloan & earce, New York, 216 pp., $4.00.

This is an excellent text on the Air orce's program in the development of uclear propulsion for aircraft, missiles nd space rockets.

During the spring of 1959 the Editors f "Air University Quarterly Review," e professional journal of USAF, learned at a significant, unclassified discussion f nuclear flight propulsion had become ossible. Plans were laid to exploit it.

Authors were chosen who were inmately concerned with the official nuear-propulsion program. They were inted to explain their specialized work oroughly but in terms understandable the non-specialist reader. The results ere published in a special issue of the eview, released in February 1960. The ntent of the issue was then made availle to the present publisher for wider blic dissemination.

ECTRONICS AND NUCLEONICS DICONARY, Nelson M. Cooke, and John Mars. McGraw-Hill Book Company, Inc., New rk. 543 pp. $12.

More than 13,000 terms used in the ctronics and nucleonics fields are deed in this newly published dictionary. shows the exact meaning and correct age of technical words, synonyms, and breviations currently being used in such eas as avionics, space electronics, nuar science, nuclear engineering, radio, dar, industrial electronics and medical ctronics.

The book is an updated and enlarged rsion of an earlier edition.

UDIES OF HEAT-RESISTANT ALLOYS, A. Coldren and others. Order PB 161667 m Office of Technical Services, U.S. Dept. Commerce, Washington 25, D.C. 108 pp., 50.

Three metallic substances were evaluad as part of an Air Force study to ercome air and space vehicle design trictions caused by creep-rupture propies of heat-resistant alloys under proction conditions.

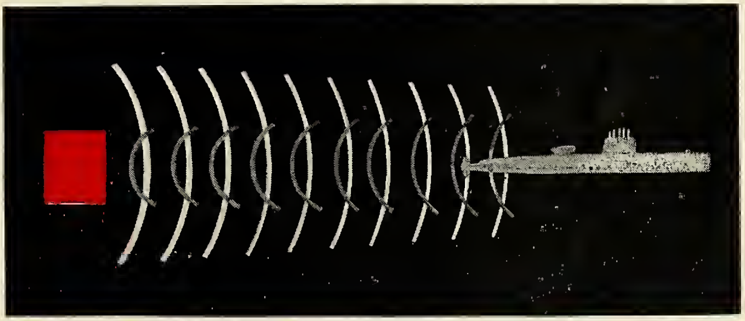
There are separate discussions of test ults for each of the three types of terials as well as descriptions of eximental procedures.

E HILL REACTION AS A MODEL FOR IEMICAL CONVERSION OF SOLAR ERGY, R. J. Marcus. Order PB 161462 m Office of Technical Services, U.S. Dept. Commerce, Washington 25, D.C. $.50.

Two ways were used in investigating possibility of storing solar energy for during dark periods by decomposing ter into its elements.

The first method investigated the elecn transfer spectra of inorganic ions. e second method concentrated on ious Hill reaction oxidants. Two new ctron acceptors were found to be ac-ti.

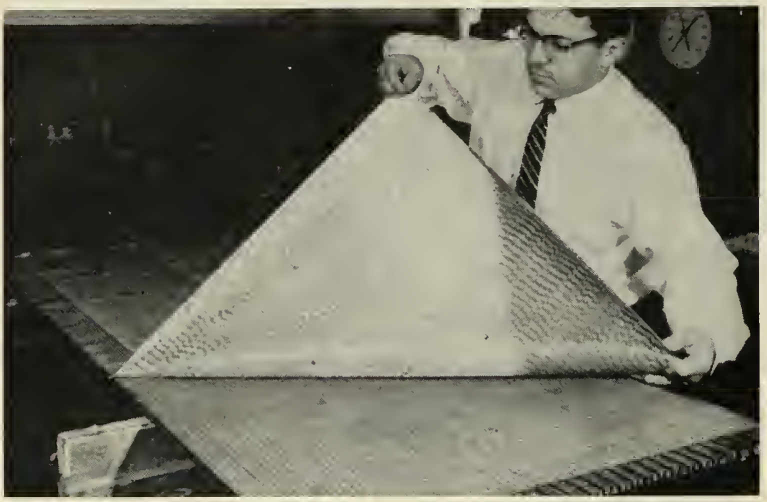
NEW
FROM
WESTINGHOUSE:
STATIC
POWER
SUPPLIES
FOR
SONAR



Static power packages from Westinghouse supply unfailing power for sonar. In unit shown at right, which will power sonar for Edo Corporation, modular packaging permits replacement of 13 diodes per unit in less than *one* minute. Ratings to meet any system range or performance can be supplied. This equipment meets Mil P-15736. For help in solving your static power supply problems, just contact your local Westinghouse sales engineer. Or write: Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania. J-92803

Westinghouse

Circle No. 13 on Subscriber Service Card.



Magnetic System Inspects Welds

Recordaflux, a magnetic particle inspection system, has been put on the market by Instruments Division of The Budd Company.

Recordaflux, formerly known as Permaweld, is used to detect defective welds, cracks, inclusions and other flaws in the materials which are currently being inspected by magnetic particle systems. The new Recordaflux system has been very successfully used by The Budd Company to determine non-destructively the diameter of spot welds in stainless steel, such as types 301 and 201 and the precipitation-hardening grades.

The Recordaflux patterns of magnetic particles show the shape and size of a spot, or other type of weld, making it easy to detect a defective joint. It will also pinpoint other flaws, such as cracks and inclusions. The patterns may be viewed on the part and washed away, or they may be stripped from the part, viewed, and filed away for reference. Copies of the patterns are readily obtained by passing the Recordaflux films through reproduction equipment.

Circle No. 225 on Subscriber Service Card.

Hole Bottom Adapter

An adapter for the Surfindicator (a precision instrument for measuring surface finish), used to measure the surface roughness of the bottoms of holes, slots, counter bores, and any area below the surface level is available from Brush Instruments, Division of Clevite Corp.

The hole bottom Adapter may be used either for hand-held or for motor driven operation with Brush Motor Drive BL-117 to measure surface roughness in the range from zero to 250 microinches. It measures the surface in bottoms of holes as small as 3/8-in. ID., to a maximum depth of one inch.

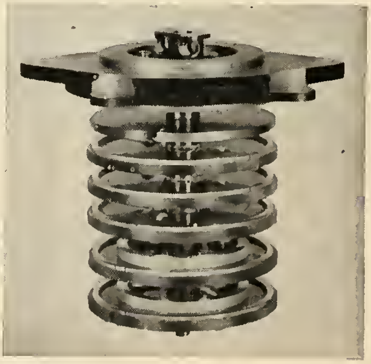
Circle No. 226 on Subscriber Service Card.

Sine-Cosine Switcher

A slip ring assembly of concentric ring type construction for switching from positive to negative for sine and cosine functions in radar antenna mounts has been announced by Breeze Corporations, Inc.

The unit accomplishes switching within 0°20′. Switching is either break-before-make or make-before-break. Phasing accuracy is 0.20′ electrical and 0.005 in. mechanical. The slip ring assemblies operate in an ambient temperature range from –65°F to 165°F.

Circle No. 227 on Subscriber Service Card.



Liquid Fuel Detection

A series of Quartector Liquid Detection Systems have just been introduced by Trans-Sonics, Inc. Designe specifically for use with storable propellants, rocket fuels, and liquefie gases, these Systems make possibl positive fail-safe sensing and control o such liquids as UDMH, N_2O_4, liqui H_2, anhydrous hydrazine, liquid O_2 liquid N, RP-1, and JP-4.

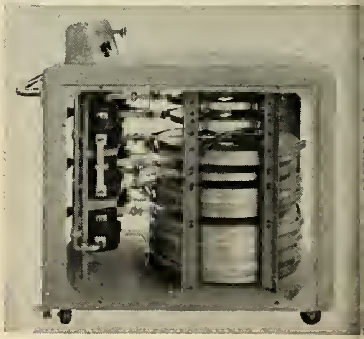
Quartector Systems utilize a poin sensor that is actuated by the dampin effect of a liquid on a vibrating quart crystal.

Circle No. 228 on Subscriber Service Card.

Coiled Delay Line

A new coiled step-variable dela line provides X-band waveguide lin lengths of from 13 to 1228 feet i short steps. It can be used to chec out as many as 64 different position in 15 minutes.

Manufactured for commercial us by Turbo Machine Co., the portabl microwave line was based on a Diamond Ordnance Fuze Laboratory technique developed some years age.



Advantages include elimination o drift inherent in long-time measurements, and eliminations of the necessit of coupling and uncoupling joints wit consequent possible contamination.

Circle No. 229 on Subscriber Service Card.

Fastest Silicon Switcher

Texas Instruments has available industry's fastest guaranteed silicon mes switcher, the 2N706A.

It is an NPN silicon mesa ultra high-speed switch designed for saturated circuitry where speed, reliabilit and performance are a necessity.

Along with the 2N706A, TI ha announced the 2N753—a high-gai version of the same transistor.

These units are expected to be designed into aircraft and missile circuits and to be used in industrial, guidance and control computer circuitry. Specific uses include such circuits as computer logic, flip flops, binary counters, trigger generators, and electronic switches.

Circle No. 230 on Subscriber Service Card.

High-Pressure Transducer

A miniature, high-pressure, high-temperature pressure transducer, capable of measuring up to 15,000 psi, and weighing less than 0.25 lb., is available from Colvin Laboratories, Inc.

Designated Series 8416, the transducers represent a reduction in the previous size of such devices of approximately 50%. They are designed to measure pressures in any range from 0 to 400 psi to 0 to 15,000 psi and are available in various resistance values. The transducers are an exact complement of Colvin Laboratories Series 401 miniature transducers, which are limited to pressure ranges from 0-1 to 0-400 psi.

Circle No. 231 on Subscriber Service Card.

Rotary Motion Transducer

Latest in Arnoux Corp.'s Transipot line of linear and rotary motion transducers for critical indicating or feedback control systems are the Transipot Models 10-R-60-1 and 10-R-30-1.

Transipots are available with ac input and ac or dc output. Typical specifications for the Size 10 linear-motion, ac to ac Transipot: Input range: ±30° and ±60°; Input voltage: 26 v ac, 400 cps; Output impedance: 5000 ohms; Independent linearity: ±.3%; Null (tuned): .1% of Full Scale; Useable frequency range: 300 to 3000 cps.

Circle No. 232 on Subscriber Service Card.

Glass-Enclosed Resistor

A glass-enclosed, precision film resistor has been put into mass production by Corning Electronics Components, a department of Corning Glass Works.

The glass enclosure is hermetically sealed; the resistor has zero moisture absorption. The NF-60 and NF-65 are 1/8-watt and ¼-watt models respectively, having a resistance range of 100 ohms to 360K ohms. Voltage ratings are 250 and 300v respectively. Derating is to 150°C.

Circle No. 233 on Subscriber Service Card.

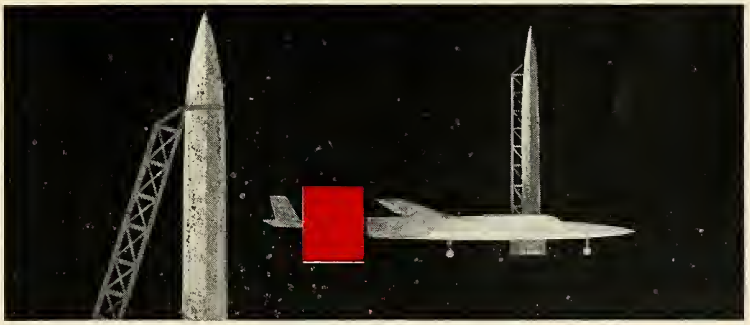
Print-Punch Cartridge

Off-line preparation of Recomp computer data tapes has been greatly speeded through use of new Print-Punch equipment being marketed by Autonetics, a division of North American Aviation, Inc.

Developed for use with Autonetics' Recomp general-purpose digital com-

NEW
FROM
WESTINGHOUSE:

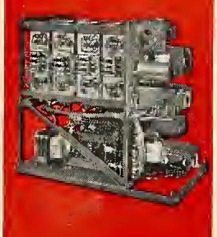
STATIC
POWER
SUPPLIES FOR
GROUND
SUPPORT
EQUIPMENT



Static inverters and converters in *kilowatts* from Westinghouse convert d-c to a-c, d-c to d-c and a-c to a-c. For ground support equipment applications—from test to launch—these inverters perform unerringly. Operation is completely static. High efficiencies, smaller size and weight, increased reliability, greater packaging flexibility, reduced maintenance are all attainable through use of Westinghouse static inverters and converters. Ratings of 10 kva are obtainable. *Higher ratings are now under development.* A 4.5 kw, d-c to 400 cycle converter is displayed at right. For help in solving your static power supply problems, contact your local Westinghouse sales engineer. Or write: Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania.

J-92504

Westinghouse



Circle No. 14 on Subscriber Service Card.

puter, the new equipment is completely self-contained. It comes in two table-top units, the 10-key input keyboard and the paper tape punch. The equipment makes it possible for Recomp users to produce manually prepared tapes conveniently off-line for rapid input of data through the computer's photo-electric tape reader.

Circle No. 234 on Subscriber Service Card.

Low Temp Spray Nozzle

Spray and spray nozzle design techniques which permit spraying of materials of lower melting temperatures with plasma spray devices, are available from Plasmadyne Corp.

The technique permits the spraying of epoxy powders at will. With melting points of but 300°F, epoxys have formerly been considered "impossible" for plasma treatment.

In addition, such materials as zinc, lead or soft solder obtainable in a powdered form may be readily sprayed.

Circle No. 235 on Subscriber Service Card.

Leadthrough Terminal

Ceramics for Industry Corp. is manufacturing ceramic-metal seal composite suitable for insertion into envelope structures by use of high temperature braze material.

This primary ceramic-metal seal is relatively isolated from terminal and envelope stresses. This feature permits the use of large diameter copper leadthroughs and high temperature seal-in procedures.

Circle No. 236 on Subscriber Service Card.

Reuseable Explosive Valve

A complete series of patented Conax Normally Closed Con-O-Cap Explosive Valves, with exclusive reuseable bodies and replacement kits, is being produced by the Conax Corp.

This series of lightweight standard models are dead-tight, shut-off valves for long- or short-time storage of gases or liquids up to 5000 psi, and operate in .002 sec. by firing a small completely contained explosive squib. Dual primers provide a reliability factor of 99.99+% at −65°F to + 160°F temperature range.

Circle No. 237 on Subscriber Service Card.

No Slide Sampling Switch

The Magnavox Research Laboratories have developed a magnetically actuated sampling switch for high-speed, low-level operations. The elimination of sliding contacts, which are inherently noise and heat generators and are also short-lived, has made possible a switch design capable of fast operation at extremely low signal levels, with life exceeding 200 million operations.

In many applications the switching unit introduces less than 10 microvolts of extraneous signal into the circuit being commutated regardless of impedance level. Dwell periods as brief as 300 microseconds and dynamic resistances of less than 1.0 ohms enable fast, accurate multiplexing of low-level transducers.

Circle No. 238 on Subscriber Service Card.

new literature

OPTICAL QUARTZ—A detailed technical description of the optical properties of Suprasil and Infrasil grades of fused quartz glass has been published in data file form by the Amersil Quartz Division of Englehard Industries, Inc. Numerous graphs and tables compare transmission, absorption, dispersion and refractive indices of Suprasil, Infrasil and other quartz types for a wide range of wavelengths and in various thicknesses. Further data, including color photographs, indicate the degree of fluorescence exhibited and the reaction of the various types to X-ray, alpha, beta and gamma radiation.

Circle No. 200 on Subscriber Service Card

BERYLLIUM APPLICATIONS—Pure beryllium tubing is described in Data Memorandum No. 26 published by Superior Tube Co. The memo gives complete information on available sizes and properties of pure beryllium tubing. Included are its physical and mechanical properties and the composition limits of the material from which the tubing is made.

Circle No. 201 on Subscriber Service Card

ELECTROMAGNETIC BALL BEARINGS—Complete engineering information on the Dynamic Bearing developed by The Barden Corp. is available in a two-page engineering data sheet. Operating qualities of the Dynamic Bearing are particularly suited to applic tions requiring extremely sensitiv ultra-low-torque characteristics such gyro gimbals, stable platforms, scal and static balancing devices. Maximu benefits are derived at very low velo ities, particularly those at, or approac ing, zero RPM.

Circle No. 202 on Subscriber Service Card

QUENCHING OILS—A bulletin pub lished by Sun Oil Company contain data on Sunquench 1070 fast-quenc oil, and Sunquench 1021, a "hot oil type of quenching medium. Typic characteristics of the new oils ar cited, together with the benefits ob tained from their use. Quenching speed measured by three widely used tech niques (including GM Quenchometer are reported for each oil.

Circle No. 203 on Subscriber Service Card.

MOLYBDENUM METAL—A 110 page handbook which provides ma terials engineers with comprehensiv information on properties, productio and fabrication of unalloyed molyb denum metals is available from Clima Molybdenum Co. The handbook place special emphasis on new advances i arc casting and powder metallurg which have made it possible to produc ingots up to 12 in. in diameter an readily convert them into billets, forgings, sheet, tubing and bars. Describe also are fabrications and joining techniques which now make possible production of molybdenum metal parts on conventional equipment for missile, space, nuclear and other applications.

Circle No. 204 on Subscriber Service Card.

EXPLOSIVE CARTRIDGES—Technical data sheet No. 2100, describing a standard series of electrically-initiated pressure-producing explosive cartridge, is available from Holex Inc. Nineteen units cover a range of energy output capacities from 10 to 135 foot pounds. Data includes space requirements, functioning time and electrical characteristics, propellant load computation data and a brief guide to the sele ction of properly rated explosive pressure cartridges.

Circle No. 205 on Subscriber Service Card.

VACUUM IMPREGNATION—Improving the dielectric efficiency of large distribution transformers, the armatures of generators and motors, ignition wiring systems, coils and capacitors, and components for radar and other electronic systems are some of the principal current applications for vacuum impregnation whose advantages are presented in detail in the revised edition of a 16-page brochure published by F. J. Stokes Corp.

Circle No. 206 on Subscriber Service Card.

contracts

NASA

,645,730—**Trailmobile, Inc.,** Springfield, Mo., for missile body shipping containers.

,382,540—**Lockheed Aircraft Corp.,** Marietta, Ga., for engineering, fabrication and associated services in support of experimental, development and research work under various space programs.

13,060—**Aerolab Development Co.,** Pasadena, for modification of *Argo D-4 (Javelin)* vehicle.

5,000—**Compressed Gases, Inc.,** Cleveland, for bulk hydrogen gas for Lewis Research Center.

4,949—**The R. Hansen Co.,** Cleveland, for furnishing and erecting cryogenic lab prefabricated building for Lewis Research Center.

5,103—**Hughes Aircraft Co.,** Culver City, for rigidication of Project *Echo* research satellite.

NAVY

ylvania Electric Products, Inc., Needham, Mass., for study of requirements for a composite terminal data distribution system for the Pacific Missile Range. Amount not disclosed.

6,047,000—**Westinghouse Electric Corp.,** Pittsburgh, for design, development and production of nuclear reactor compartment components for the fleet ballistic missile submarines.

08,000—**Solar Construction & Engineering Co.,** Houston, for construction of strategic missile facilities.

273,201—**Lasko Metal Products, Inc.,** West Chester, Pa., for metal containers for guided missiles, *Mark 33.*

00,000—**Elgin National Watch Co.'s Elgin Micronics Division,** Elgin, Ill., for production of high-precision fuses for the *Sidewinder.*

75,000—**Ford Motor Co.'s Aeronutronic Div.,** Newport Beach, Calif., for investigating the feasibility of an undersea warfare device.

9,878—**ACF Industries, Inc.'s Electronics Div.,** Riverdale, Md., for services, labor, material and facilities to manufacture guided missile warheads and extra rod bundles.

3,172—**ITT's Federal Div.,** Fort Wayne, Ind., for services, material and equipment to fabricate electronic firing devices.

5,635—**Minneapolis-Honeywell Regulator Co.,** Los Angeles, for magnetic tape recorder/reproducer system.

5,500—**U.S. Rubber Co.,** Wayne, N.J., for development and study of high-temperature-resistant polymeric materials.

1,235—**Elgin Watch Co.'s Micronics Div.,** Los Angeles, for labor, services, material, facilities to develop, fabricate and test fuze-triggering devices.

ARMY

estinghouse Electric Corp., Pittsburgh, for production engineering measures for silicon controlled rectifiers. Amount not disclosed.

uclear Corporation of America, Denville, N.J., for the development of a Tactical Beta Gamma Monitoring Instrument designated Radiacmeter IM-145 (XE-1)/UD. Amount not disclosed.

14,455,000—**General Electric Co., Heavy Military Electronics Dept.,** Syracuse, N.Y., for production of high-power acquisition radars (HIPAR) for use with the *Nike-Hercules.* Subcontract from Western Electric Co.

2,067,414—**Chrysler Corp.,** for production of miscellaneous spare parts for the *Redstone* missile system.

739.382—**Raytheon Co.,** Waltham, Mass., for replenishment repair parts for the *Hawk* system (three contracts).

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Westinghouse packages silent, lightweight, static transformer-rectifier units now in use on Snark and Sergeant missiles, Lockheed Electra and U.S.A.F. C-130 aircraft. The 200 ampere regulated d-c power supply shown at right is used on the Lockheed Electra. Size: 0.4 cu. ft. Weight: 19 lbs. Regulation is never more than ±.8 volts under all input conditions. Our breadth and depth of line in T-R units meets any specific altitude or environmental condition. For help in solving your static power supply problems, contact your local Westinghouse sales engineer. Or write: Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania.

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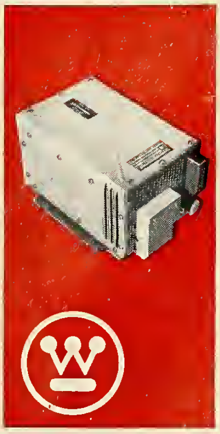

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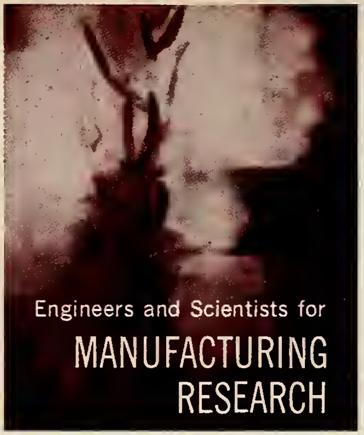

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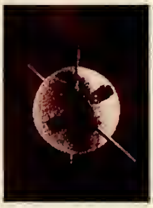
PHYSICS—Studies include neutron absorption, shielding, radioisotopes, and metal surface conditions and phenomena, plus effects of internal and external forces on molecular structure. This group is pursuing the theoretical analysis of crystal structures, metals, ceramics, infra-red, x-ray diffraction, electron microscopy testing, and use of electromagnetic fields in producing useful work.

Convair/San Diego's Applied Manufacturing Research & Process Development Department has extensive laboratory facilities available and also retains outside laboratories and consultants for specialized research and analysis.

For additional information, or to arrange a personal interview in your area, send a brief resume to Mr. M. C. Curtis, Industrial Relations Administrator-Engineering,



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San Diego, California

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. . . contracts

$726,904—Southern, Waldrip & Harvick Co., Long Beach, Calif., for SAC missile facilities at Beale AFB.

$624,099—Arvol D. Hays, Lubbock, Tex., for strategic *GAM 77* missiles for Walker AFB.

$168,972—Duval Engineering & Contracting Co., Jacksonville, Fla., for construction of *Saturn* unloading facilities, Patrick AFB.

$151,482—International Builders of Florida Inc., Coral Gables, for construction of two theodolite tower structures at Cape Canaveral.

$92,900—M. W. Hills Construction Co., Salina, Kan., for construction of re-entry vehicle, Schilling AFB.

$55,194—Raytheon Co., Waltham, Mass., for retrofit kits for *Hawk* system.

AIR FORCE

Atlantic Research Corp., Alexandria, Va., for development work on high volumetric heating value slurry fuels for ramjet engines. Amount not disclosed.

$6,000,000—Sylvania Electric Products, Inc., Waltham, Mass., for inter-site communications systems at two *Atlas* missile squadron bases.

$1,500,000—Aeronautical & Instrument Div. of Robershaw-Fulton Controls Co., Richmond, Va., for production of six helium regulators to be used in the *Titan.*

$1,200,000—Hughes Aircraft Co., Culver City, Calif., for production of electronic checkout equipment for the *Titan.* Subcontract from The Martin Co.-Denver.

$967,000—Avco Corp.'s Advanced Development Div., Wilmington, Mass., for design and production of satellite re-entry shield. Subcontract from Lockheed Aircraft Corp.

$500,000—General Motors Corp., AC Spark Plug Div., Flint, Mich., for depot level maintenance of the *Thor* inertial guidance system including associated ground and operating equipment.

$440,000—United Electrodynamics, Inc., Pasadena, for production of telemetry equipment for use with the *Minuteman.* Subcontract from Boeing Airplane Co.

$429,930—Wheeler Electronic Corp., Waterbury, Conn., for R&D for high-reliability transformers for use with the *Minuteman.* Subcontract from North American Aviation Inc.'s Autonetics Div.

$300,000—HRB-Singer, Inc., New York City, for special airborne electronic countermeasure equipment for the Quick Reaction Capability facility at Wright-Patterson AFB.

$153,000—American Bosch Arma Corp., Arma Div., Garden City, N.Y., for depot test equipment required to support the *Atlas* inertial guidance system.

$102,833—General Electric Co., Missile & Space Vehicle Dept., Philadelphia, for depot-level maintenance of MK II re-entry vehicle airborne and ground support equipment and components.

$100,000—Douglas Aircraft Co., Inc., Santa Monica, for system integration and in-service engineering support of *Thor* weapon system.

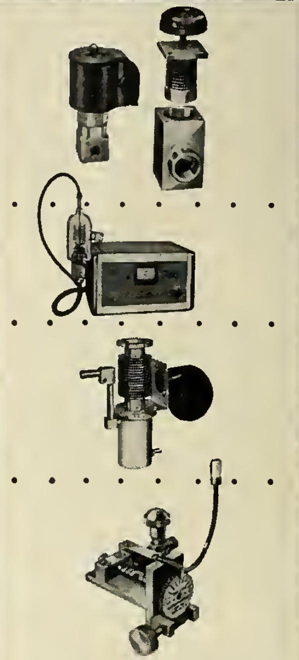
$100,000—North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., for in-service engineering and propulsion subsystems and related ground support equipment.

$50,000—General Motors Corp., Flint, Mich., for services and supplies to operate a contractor storage site in support of the *Thor* guidance system.

MISCELLANEOUS

$190,000—Summers Gyroscope Co., Santa Monica, Calif., for spring-wound gyros for missile use. Subcontract from The Martin Co.-Orlando.

trouble-free
HIGH VACUUM
COMPONENTS



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—when and where—

SEPTEMBER

13th General Assembly of the International Scientific Radio Union, University College, London, Sept. 5-15.

International Summer Course on Solid State Physics, sponsored by: Italian Physical Society, in cooperation with NATO, CURATOM and National Committee on Nuclear Research, Italian Nuclear Energy Center, Varese, Italy, Sept. 5-24.

Society of British Aircraft Constructors Show and Flying Display, Farnborough, England, Sept. 6-11.

Electronics Industries Association, Second Conference on Value Engineering, Disneyland Hotel, Anaheim, Calif., Sept. 7-8.

Joint Automatic Control Conference, Massachusetts Institute of Technology, Cambridge, Sept. 7-9.

AGARD, Seminar jointly sponsored by AGARD and the Instituto Lombardo di Scienze e Lettere, "Propulsion for Astronautics," Varenna, Italy, Sept. 8-12.

American Chemical Society, 138 National Meeting, New York City, Sept. 11-16.

Second International Congress in the Aeronautical Sciences, sponsored by the International Council of Aeronautical Sciences, Zurich, Switzerland, Sept. 12-16.

IIIrd International Congress on Surface Activity, Cologne, Germany, Sept. 12-17.

Electronics Industries Association Fall Conference, Sheraton-French Lick Hotel, French Lick, Ind., Sept. 13-16.

Engineering Management Conference, sponsored by American Institute of Electrical Engineers and American Society of Mechanical Engineers, Morrison Hotel, Chicago, Sept. 14-16.

Armed Forces Chemical Association, 15th Annual Meeting, Sheraton-Park Hotel, Washington, D.C., Sept. 15-16.

Institute of Radio Engineers, National Symposium on Space Electronics & Telemetry, Shoreham Hotel, Washington, D.C., Sept. 19-22.

Ninth Annual Symposium on Industrial Instrumentation, sponsored by Institute of Radio Engineers and American Institute of Electrical Engineers, Manger Hotel, Cleveland, Sept. 21-22.

ASME-AIEE Power Conference, Bellevue-Stratford Hotel, Philadelphia, Sept. 21-23.

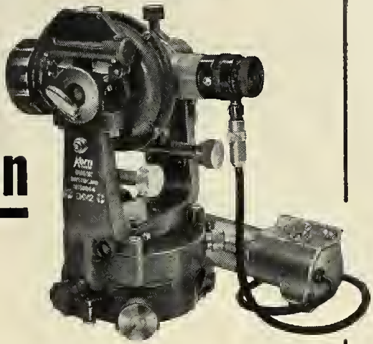
Air Force Association, National Convention and Aerospace Panorama, San Francisco, Sept. 21-25.

American Ceramic Society, Electronics Division, Schroeder Hotel, Milwaukee, Sept. 22-23.

American Institute of Chemical Engineers, Mayo Hotel, Tulsa, Okla., Sept. 25-28.

Electronic Industries Association, National Convention, Pittsburgh-Hilton Hotel, Pittsburgh, Sept. 26-28.

American Welding Society Fall Meeting, Penn-Sheraton Hotel, Pittsburgh, Sept. 26-29.



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Wants Positive Thinking

To the Editor:

(Regarding the editorial, "The Leaden Feet of NASA's Mercury," M/R, Aug. 15), did you recommend *Dyna-Soar* as the man-in-space project when *Mercury* was started? The world is full of cracker barrel experts with "hindsight." How about some usable constructive thinking which might lead to a solution to problems?

John Nicol
Fairview Park, Ohio

Titans Welcome

To the Editor:

As a native of Tucson, as well having been employed in several phases of missile engineering during the last 11 years, let me assure you that the opinion of Mr. J. E. McDonald with reference to the Tucson *Titan* bases definitely does not reflect the opinion of a majority of the population of Tucson. Mr. McDonald's group is, indeed, an exceptionally small but noisy minority.

The Tucson *Titan* sites were, in actuality, quite well chosen with respect to logistic requirements and ESCAPE ROUTES. Lethal fallout would be just as likely from an attack on any other sites in the area which would be suitable or available for *Titans.*

Mr. McDonald's group has also failed to take into consideration the fact that Tucson proper is considered a primary target for enemy attack due to the location of Davis-Monthan Air Force Base, a SAC installation.

By far the greater majority of the citizens of Tucson welcome the *Titan* bases, regardless of location. The feeling is that the bases will definitely prove beneficial to the economy of the Tucson area, while not necessarily increasing the likelihood of enemy attack.

William J. English
Field Engineering Rep.
White Sands Missile Range
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Colonists by Sufferance?

To the Editor:

Mr. Truax may be the foremost authority on rockets and a pioneer in rocket development, but his article entitled "Planets to be Colonized in 50 Years" (M/R, Aug. 8, p. 38) only points up the fact that he and all too many other scientists and engineers today are very narrow-minded and even possibly egoists about Man's intelligence.

Their implication that Man is the highest order of intelligence (on this planet)—ergo, the only intelligent being in the entire Universe—is just too limited for my way of thinking.

It is my contention that the miniscule bit in the vastness of space on which we live is not the only place inhabited by intelligent beings. These others may not be fashioned after our mold, but are undoubtedly intelligent—perhaps further advanced than we.

It is not inconceivable to one who believes in God also to believe in the Steady-State Theory or to anticipate and accept the fact that in His infinite wisdom there were created other beings in other environments, and that these beings may be of a higher and more advanced intelligence than Man's.

Another thought that has occurred to this writer is the fact that our planet Earth—by whatever name these other intelligent beings may know it—may well be called by them "Experiment Earth," and that our pitifully meager beginnings at probing this solar system, our galaxy, or the galaxies beyond are being carefully watched—much as we keep careful watch over our microbe cultures, test tubes, etc.

With the foregoing thoughts in mind, the so-called "permanent colonies on the moon, Mercury, Venus, Mars and, perhaps, on the moons of Jupiter and Saturn," following the explosive spaceflight expansions predicted over the next 5 years, may be possible—but only with the permission of these intelligent beings who may be inhabiting those self-same planets and/or their natural or mechanical orbiting satellites.

Perhaps these thoughts have been put too sharply, but I have been reading so many papers, articles and newspaper stories along these lines that I thought someone should speak out about these possibilities. I would be very much interested to know whether there are others with similar, unstated thoughts.

Vehig S. Tavitian
Managing Editor
Special Publications
Institute of the Astronautical Sciences
New York City

P.S. The editorial, "How Bold, How Imaginative?" on p. 50 of the same issue takes the same premise (as the article).

P.P.S. This is a personal reaction—*not* an official communication.

LOX Relief Valves

To the Editor:

I noticed that the COUNTDOWN in the Aug. 1 M/R referred to the giant cryogenic valves installed by Elmco. Of equal interest are 14-in. LOX vent relief valves designed and manufactured by Anderson, Greenwood & Co. for Rocketdyne. They are used on the same system at Edwards AFB and I believe they are probably the largest single relief valves to be made, certainly the largest and finest ever made for this service.

W. W. Hering, Sales Mgr.
Industrial Products Div.
Anderson, Greenwood & Co.
Houston, Tex.

Telescope Engineering

To the Editor:

On page 19 of the Aug. 1 M/R you show a photo of a rendering of a 1000-ft.-diameter radio telescope. The caption under the photo did not indicate the organization responsible for the engineering.

Our office provided the drawing appearing in the photograph and our Mr. T. C. Kavanagh is acting as chief engineer of the joint venture responsible for the engineering: Von Seb, Inc.; Developmental Engineering Corp.; Severud-Elstad-Krueger Associates and Praeger-Kavanagh.

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GENERAL ELECTRIC

Northern Lights Office Building, Syracuse, New York

editorial . . .

The Aerospace Strategic Force

IN A RECENT SPEECH at Fort Worth, General Curtis LeMay took the time to state some old and some new military doctrine as it applies to the U.S. military situation today.

General LeMay is presently Vice Chief of Staff of the Air Force. He has held that position almost four years and will almost certainly succeed soon to the post of Chief of Staff. Before that, he was commander of the Strategic Air Command almost from the inception of SAC.

There are those who tend to discount the LeMay opinions as those of a rabidly partisan air doctrinist. But there are few if any who do not regard him as a tough-minded, realistic and competent general officer.

Significantly, General LeMay apparently regards our present mixture of unmanned missiles and aircraft as an interim step toward a strategic aerospace force wherein the manned spacecraft and possibly the manned missile would be dominant.

Warning that our deterrent force is not a true deterrent unless it has the capability of absorbing a surprise attack and still striking and restriking back, LeMay says:

"Our counterforce capability must be a carefully prepared, maintained, modernized and controlled blend of strategic weapons. We must select the best systems devised, in the proper quantity, and attain simplicity of operations for assurance of victory."

"Having both fixed and mobile missile systems in our force adds to our overall capability . . . But the number of missiles in each type of delivery system must be carefully weighed." And he continues:

"We are not placing all our reliance on the unmanned systems. With manned *aerospacecraft* . . . a nation can react to a variety of situations in a variety of ways . . . Manned *aerospace* forces give a nation options ranging from ground alert to launch of the force subject to recall. Manned *aerospacecraft* can be effectively used as a show of force . . ."

We have long held that earthly wars as we know them are outmoded and unfeasible and that both the danger and the deterrent of the near future will be in space.

This does not mean that we can or will neglect our earth-bound forces and fail to keep them just as strong and as diverse as the enemy's. It does mean that with present-day weapons no nation can start a great war with the expectation of anything except his own destruction.

In this aerospace strategic force LeMay speaks of—what do we have? Not the B-52 or the B-58. Not even the B-70, although all three could launch comparatively long-range missiles for which there is little defense.

NO, AN AEROSPACE weapon is an actual space-flying weapon system—*Dyna-Soar* and its successors. They will be of infinite variety, from manned missiles to huge spacecraft. They can be boosted from the earth by external means as we now know them. Or they can be large enough to create their own oxygen-hydrogen fuel as they climb into orbit.

Whatever they are or will be—they should be on this nation's drawing boards now, and in the development stage just as soon—the day or week—as our capabilities permit. Not months or years later.

For the Russians will have a man in space soon. Their gainful occupation of space is just a short step further. If they reach the point where they can dominate space—then they can find a way to dominate the world.

Clarke Newlon

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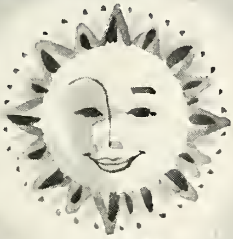

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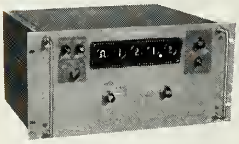

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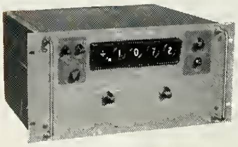

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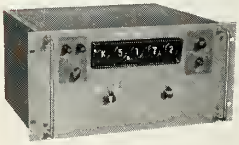

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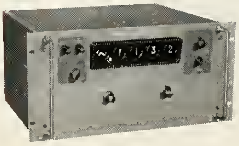

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SEPTEMBER 12, 1960

missiles and rockets

HE MISSILE/SPACE WEEKLY

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20 Reasons

for using Hadley
cryogenic
fluid controls
in new
hydrogen
super-thrust
missiles

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Immediate openings on
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Two of the advanced projects on which Boeing is a major contractor are the Dyna Soar boost-glide vehicle and the Minuteman solid-fuel ICBM. The steady expansion of these long-range programs at Boeing has created openings for six electrical/electronic engineers. Salaries are $10,000 and up depending upon background.

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Four assignments available, entailing the preparation of electrical/electronic manufacturing process specifications which describe engineering requirements for shop manufacture of electric wiring installations and electronic packaging. Preparation of material and component specifications for electrical materials such as insulated wire and cable, connectors, and wiring devices. Development of improved electrical installation techniques to suit new applications in missiles and aircraft, and prove suitability of new techniques, materials, and wiring components by laboratory test. Duties include coordination with design engineers, manufacturing, quality control, purchasing and vendors. Requirements are a B.S.E.E. degree, and two to six years of electrical/electronic equipment design or process experience, with ability to write electrical requirements.

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THE MISSILE/SPACE WEEKLY

missiles and rockets

September 12, 1960 Volume 7, No. 11

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31,026 copies this issue

Engineering notes from the **SM/I REPORTER**

BY STANLEY M. INGERSOLL, *Capabilities Engineer*

Report No. 10
AQC 600 Propellant Utilization Control System

For maximum efficiency from a liquid propellant missile, fuel and oxidizer must be depleted simultaneously. Our new AQC 600 system, which consists of a controller and a differential pressure ratio sensor, measures the pressure ratio of fuel and liquid oxygen remaining in the tanks of a missile at any given time — then accurately controls the flow of these propellants into the combustion chamber. The percentage of accuracy is based on the propellants remaining in each tank, not on the full scale quantity. This reduces the absolute error signal as the propellant levels are decreased. The SM/I system measures the liquid head of each propellant and computes the ratio between the two head pressures electromechanically. An amplified error signal actuates a valve that changes the relative flow between fuel and liquid oxygen until the error signal is reduced to zero.

Typical Performance Specifications

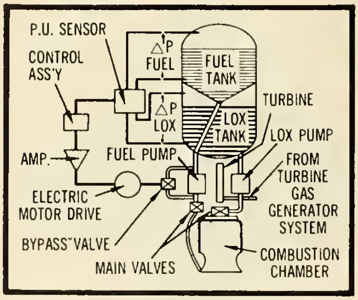
Pressure Conditions
Max. line pressure .... 120 psig
Max. differential pressure ... 35 psid
Min. differential pressure ... 0.2 psid
Ambient .... 0-15 psi
Gaseous medium .... Gox, Helium, N2, Air or H2

Electrical
Input .... 115 volts, 400 cps, 10W
28 VDC — 1 amp.
Heater Voltage .... 28 VDC — 30 watts
(used only below 35°F)

Environment
Vibration .... 10-38 cps ±20 g's
38-2000 cps ±20 g's
Shock .... 30 g's
Acceleration .... 15 g's (one axis)

Accuracy (on basis of ratio)
Sensor .... ±0.5% Computer... ±0.15%

Weight
Sensor .... 3.8 lb Controller... 4.8 lb



Photograph and over-all system diagram

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Hawthorne, California

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—letters—

German Rocket Groups

To the Editor:

In your article on "IAF Congres Finds No Agreement on Space Control' (M/R, Aug. 29, p. 43), a mistake slippec your attention:

The Deutsche Astronautische Gesellschaft admitted to IAF membership i the *East* German aeronautical society tha applied for membership under the name "Astronautische Gesellschaft der Deutschen Demokratischen Republik."

As the East German puppet state i not recognized by Western governments the society would have had little chance of being accepted and therefore changec the name in the course of the IAF Congress to "Deutsche Astronautische Gesellschaft." It is not correct that only one society will have the full voting rights Two West German societies, the DRG and the DGRR are members of the IAF while the latter has the full rights. The DGRR tried in vain to prevent the East German society becoming a member with voting rights, but was overruled by al other voting members. The procedure caused bitter comments in the Germar press.

Erhard Heckmanı
Editor
Flugwelt
Köln

Through an error in processing of th story, M/R incorrectly identified the grou admitted to membership as West Germar We are grateful to Herr Heckmann for th correction.—Ed.

Radioplane and Mercury

To the Editor:

Your very excellent article in the Au 1 M/R ("Parachute Recovery System Being Refined") carries the implicatio that Cook Electric Research Laboratori is in some way responsible for NASA Project *Mercury* landing system. The fac are that the Radioplane Division of Nort rop Corporation was selected by NAS and McDonnell Aircraft (prime contra tor for the *Mercury* capsule) to devel and produce the *Mercury* landing system.

Radioplane has successfully landed t *Mercury* capsule 53 times in tests fro aircraft at launch altitudes from 2000 30,000 feet. In addition, Radioplane lan ing equipment has been used in many ca sule system tests by NASA, includi *Little Joe, Big Joe,* Capsule No. 1 esca rocket test and several aircraft drops.

We are intensely proud of our p in this most vital project to place the fi American in orbital space flight. In fa the Ringsail parachute which will bri the astronauts safely to earth was vented by one of our engineers who has been tackling tough recovery problems requiring super reliability here at Radioplane for many years.

We feel certain that CRL is probably as anxious as we are to have this misconception corrected so as to avoid embarrassment or confusion on other space recovery projects in which both Radioplane and CRL are engaged.

W. H. Freeman
Director, Paradynamics Group
Radioplane Div., Northrop Corp.
Van Nuys, Calif.

M/R of course did not intend to misplace the credit which rightfully belongs o Radioplane. Actually, we did not say hat Cook was responsible for the Mercury anding system; we did report that Cook contributed much of its past experience to assisting NASA in developing the system. The first drogue chute used on Mercury was produced by Cook; Radioplane's chute s now being used.—Ed.

Optics Coverage Cited

To the Editor:

I congratulate you on your excellent eport on optics in the Aug. 22 issue. You have really covered the waterfront. I was especially pleased to note your eferences to the materials needs, since we have some interest in this field.

I liked your "no nonsense" approach —perhaps best illustrated by the statement, "This bias is well grounded in gnorance," referring to the arguments of those who believe that optics is obsolescent.

James Balog
Manager, Market Planning
Electronic Chemicals Div.
Merck & Co., Inc.
Rahway, N.J.

To the Editor:

We were pleased to note the fine coverage of K & E specifically, and the readth of your entire optical report in eneral. The Optical Industry needs more ditorial emphasis than it has received in he past.

Albert W. Chapple
Marketing Manager
Optics and Metrology Div.
Keuffel & Esser Co.
Hoboken, N.J.

To the Editor:

Congratulations on the excellent optics oundup. Somehow our numbers were garbled in transmission. The ballistic camera Nortronics is developing for the Air Force (M/R, Aug. 22, pp. 26, 27) is a 500-mm (not 60-mm) camera. It will be he largest camera of its type ever built n this country.

Marc Nault, Public Relations
Nortronics Div.
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Heat Problem?

DUMONT CAN HELP

High-temperature insulation for missile components is a major space-age problem...and a Dumont specialty. Polaris and Minuteman already testify to the experienced skills of Dumont in high-pressure molding of reinforced plastics. Characteristic of Dumont's ability to meet new challenges with new solutions is the development of the first tactical lightweight plastic exhaust nozzle to combine structural and insulating components into a single assembly. The future of missile flight is dependent upon thermal insulating requirements of rocket motors, nose cones, re-entry vehicles. Dumont's advanced techniques of high-pressure compression and autoclave molding, supported by process and materials development, are already prepared to meet those requirements.

Dumont's experience and technology in the field of high-temperature insulation and sandwich structures are available through its technical service staff. Learn how Dumont's facilities and abilities can help you find insulation answers. Write today for Brochure D.

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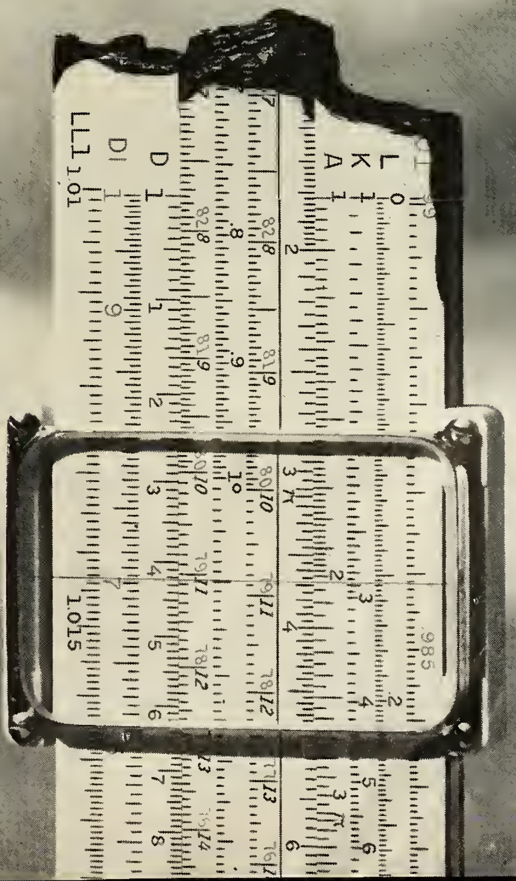

Every day we move another step closer to using the natural resources of other planets

Development of nuclear power, utilized in space ships like this Douglas concept, will speed the day when man will travel in outer space and use its resources.

Air Force space studies aimed at cracking military problems also reveal potential civilian benefits

Progress in space research is so rapid that consideration must now be given to projects you'd have scoffed at a few years ago. For instance, development of a nuclear rocket could drop payload costs so low that it would be economically worthwhile to import rare materials from other planets.

Projects such as this are the daily fare of engineers at Douglas. Right now they are studying the many problems related to interplanetary exploration: Can humans survive? What about temperature, gravity, water, food . . . and fuel for the return trip?

Douglas has been finding answers to such problems since 1941. These answers are seen in action every time a Douglas-built Thor boosts another payload into space.

DOUGLAS

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he Countdown

WASHINGTON

o The Bitter End

The Eisenhower Administration apparently hopes to hold the line on defense spending—even after it passes from office. It has directed the military services to draft FY '62 budgets based for the most part on either modest increases or reductions. COUNTDOWN hears that Pentagon budgeteers are now in the process of drafting four budget models for the outgoing administration. Model A is 5% under FY '61. Model B is identical with FY '61. Model C is 5% more. And Model D includes a list of items that the services feel they ought to have in case the country might have to fight a war.

ercury Investigation Still Pending

Some congressmen went home talking about the possibility of investigating NASA's *Mercury* man-in-space program immediately after the presidential election, rather than wait until January. But, whether they will hold it early apparently still depends upon what Russia does in the space race in the next few months.

ore Mercury Slippage

NASA has just about given up hope for a downrange manned *Mercury* capsule shot aboard a *Redstone* until the end of 1960. The first unmanned *Mercury-Redstone* is scheduled to go in a few weeks. If all goes well, it will be followed by one with a monkey in the capsule and the manned shot.

INCPAC Goes Hard

An abandoned World War II underground airplane factory—reportedly 200 ft. underground on the Island of Oahu—is being converted into a command post for CINCPAC (Commander in Chief of the Pacific). The facility, with a cafeteria to feed 30,000 persons, is being made chemical-biological-radiological warfare-proof.

econd Round

The Army is now expected to award study contracts for a mobile battlefield anti-missile system in about a month. Several dozen contractors are in the competition. On the first time around, the Army turned down all the proposals submitted by more than 40 companies—apparently on grounds that their concepts for such a system were not revolutionary enough.

ourier Launch Date Set

Latest date set for the launching of the Signal Corps' *Courier* delayed repeater communications satellite is now Oct. 2 from the Cape.

INDUSTRY

roubles for Aerospace Corp.

COUNTDOWN is told the Air Force's new Aerospace Corp. has run into organizational troubles so serious that Space Technology Laboratories is quietly working on some of the contracts intended for the non-profit agency. Aerospace Corp. presently has only 500 of the 1400 personnel it was scheduled to have by now. STL, incidentally, is suffering from recruiting raids on its engineering staff.

Contributor to Base Slippage?

One industry source believes that insurance companies may be contributing to the lag in ICBM base construction—by being too easy in bonding sub contractors. The contention is made that the bonding companies feel there is practically no risk on their part, no matter who the contractor, since payment by the government is guaranteed even if the bonding company has to fulfill the contract. Thus, unqualified subs get in the program.

Bogies on the Board

ICBM base building "czar"—Maj. Gen. Thomas P. Gerrity—has set up a 24-hr. command post in the AMC's Ballistic Missile Center to trouble shoot construction delays. Using a system akin to the Air Defense Command, duty officers post problems arising at any of the bases on a chart as "bogies." Special teams are given 24 hrs. to "shoot down" the bogies before the problems are referred to the direct attention of Gerrity or his deputy.

BuShips Adds Space Office

The Bureau of Ships has just created an Astronautics branch within its R&D office. The new group will be handling shipboard support work for such systems as *Transit, Advent* and a seagoing mobile satellite launcher.

Skybolt Test Equipment High

J. W. Fecker Division of American Optical has just picked up two contracts (over $1 million each) for electro-mechanical turntables to test all-inertial gyro packages. One is with Nortronics for the Douglas *Skybolt* and the other for Convair's *Atlas*.

INTERNATIONAL

Space Communications Network

Sweden's Ericsson Group soon will firm up plans for a "spacewide" satellite communications center through their U.S. manufacturing subsidiary-North Electric Co. The latter already holds contracts in the *Thor, Jupiter* and BMEWS programs.

Italy's New Electronics Giant

With its new agreement to use the facilities of Microlambda, missile guidance subsidiary of Finmeccanica, Selenia, S.p.A. probably will be rated as Italy's largest single electronics firm. Raytheon holds a 40% interest in Selenia, Finmeccanica 40% and Italian Societa Edison the remaining 20%.

Nord is Humming

Backlog at Nord Aviation shows 37,500 *SS 11* and 26,200 *SS 10* antitank missiles on order. *SS 10*'s are rolling off the production line at 1000-per-month rate. At the start of next year, *SS 11* production will hit 2000 per month. Total French missile exports (mostly Nord products) are expected to total $30 million in 1960.

The Overseas Pipeline

A new German rocket test site will be built near Soltau not far from Hannover . . . Meteor, S.p.A. has just revealed two new drones built by their plants at Trieste and Gorizia . . . Revue Militaire Suisse says the U-2 pinpointed 40 Soviet ICBM sites of which 20 had anti-aircraft missiles.

Up to $100 Million . . .

NASA Picking Prime for OGO

The National Aeronautics and Space Administration is asking for bids by Sept. 26 on the prime contract for the Orbiting Geophysical Observatory, which could amount to $50 to $100 million over the next eight years.

The initial contract will call for R&D and delivery of three flight spacecraft within three years after authorization to proceed. NASA's Goddard Space Flight Center also asked for estimates of cost of delivery of one or two spacecraft a year for the subsequent five years.

The OGO is to weigh about 1000 lbs., of which at least 150 lbs. will be assigned to as many as 50 scientific experiments. It must have a potential of growth to 1500 lbs., of which at least 500 lbs. must be assigned to experiments.

The satellite must be mountable on *Agena-B* or *Centaur* upper stages. The first launch (EGO) will be on an *Atlas-Agena B* down the Atlantic Missile Range, aiming at an eccentric orbit (perigee 150 naut. mi., apogee 60,000 naut. mi.) of 31° inclination. The second launch (POGO) will be on a *Thor-Agena B* down the Pacific Missile Range, aiming at polar orbit (perigee 150 naut. mi., apogee 600 naut. mi.)

First launching is to be 27 months after authorization to proceed.

Scientific experiments carried aboard the OGO satellites will include measurements of:

–Magnetic fields—magnitude, direction and variation.

–Energetic particles—composition, flux and energy spectrum.

–Dust—composition, flux and energy spectrum.

–Atmospheric structure—pressure, temperature, composition and density.

–Ionosphere—electron and ion densities and temperatures.

–Solar physics — ultraviolet, X-ray and gamma region monitoring.

–Astronomy—Stellar emissions in the ultraviolet, X-ray, gamma and very low frequency regions.

–Meteorology—earth weather parameters.

–Planetary parameters — properties of planetary surfaces and environment.

–Technology—tests of power supply, thermal control, structural systems and the like.

–Biology—behavior of various life forms in space conditions.

–Miscellaneous—night airglow radiation, auroral radiation, vehicle charge, electrical fields, etc.

The spacecraft is to be stabilized so that the same axis constantly points toward the earth, with a 2° permissible error during an active life of one year. At least 20 lbs. of experiments are to be oriented along an axis stabilized in the plane of the satellite's orbit, with a 5° permissible error. Another 20 lbs. of experiment must be oriented along an axis pointing at the sun, with a permissible error of 20°. Both gas jets and reaction wheels will be used as torque generators.

The experiments will be installed in modular compartments. Some modules, however, may carry more than one experiment while some experiments may occupy the space for more than one module.

The satellite must have a minimum of 30 sq. ft. of exposed surface area. Of this 10 sq. ft. must point toward the earth, 10 sq. ft. away from the earth, 4 sq. ft. forward in the plane of the orbit, 2 sq. ft. toward the sun, 1 sq. ft. away from the sun and 1 sq. ft. aft in the plane of the orbit.

The spacecraft will have two beams capable of in-flight extension to 15 ft. or longer at 180° opposition to one another. Each beam will carry 5 lbs. of experiments in the volume of 0.25 cu. ft.

NASA suggested a maximum diameter of 56 in. to allow enclosure during launch in a 5-ft.-diameter shroud to match with the diameter of *Agena-B* and *Centaur*. However, projection beyond 5 ft. is allowed if the additional aerodynamic drag is taken into account.

Power supply will be solar cells and storage batteries providing an average 40 watts at a nominal 18 volts and up to 80 watts intermittently. The satellite will have three telemetry systems: a wideband system operating either at 400-800 mc or 136-7 mc for the bulk of data, with a bit rate up to 200,000 bits a second; a narrow-band system on 136-7 mc to telemeter up to 10 experiments, with a bit rate up to 50 a second; and a special purpose telemeter at 300-400 mc with a sinosoidal signal that varies with the range from 5 cps to 270 kc. with maximum frequency at perigee.

Anderson Hits Rover Contracting

Sen. Clinton P. Anderson (D-N.M.) says the possibility of a ground launching as a first test of the project *Rover* nuclear rocket probably will be ignored now that a National Aeronautics and Space Administration official controls the project.

Anderson, Chairman of the Joint Committee on Atomic Energy, recalled that some NASA officials have said that the first test of *Rover* should be as an upper stage of a *Saturn* booster and that Lockheed Aircraft Co. and The Martin Co. are to make six-month studies of program requirements.

"Will their contractors see it differently?" Anderson asked. "I suspect not."

The senator questioned what he called a device of "policymaking by contract" and added:

"A council headed by the President was established to set overall space policy. This year the Administration proposed the elimination of the Space Council and—interestingly enough—any participation by the Chairman of the Atomic Energy Commission, who sits on the Council."

The bill to eliminate the Council, passed earlier by the House, died in the Senate. Majority Leader Lyndon B. Johnson, Chairman of the Senate Space Committee, said in a memorandum that a new President in 1961 might hold different views about NASA organization.

The bill also would have changed the law to give NASA more flexibility in waiving claim to patents developed under its contracts, squaring its policy with that of the Department of Defense.

Johnson said the patent law changes are not urgent and should be deferred until completion of a study of overall reform of patent rules by the Senate Judiciary Subcommittee on Patents.

The Missile/Space Week

Texaco Picks up Big Fuel Contract

One of the largest research contracts ever made by the U.S. Air Force for the development of new high energy liquid propellants has been awarded to Texaco, Inc.

The $1.3 million contract calls for a comprehensive study of the whole liquid propellant program and the development of advanced fuels that will solve many of the problems now surrounding the handling and storage of high energy liquids. Basic aim of the contract is the development of propellants that have all the advantages and performance capabilities of liquids combined with some of the handling simplicity and compactness of solid fuels.

Space Flight Hit by Radiation Limit

Radiation shielding problems for manned spaceflight will be further complicated by an AEC ruling which goes into effect Jan. 1. Lifetime exposure limits will be slashed from 15 rems per year to five, with not more than three rems in any one quarter. This undoubtedly will affect NASA's Project *Apollo* and possibly the Air Force *Dyna-Soar,* as well as handlers of radioactive materials in industry.

Echo's Skin Develops Wrinkle

A slight wrinkle has apparently developed in the skin of the *Echo I* balloon satellite. NASA said this accounts for the apparent variation in *Echo's* brilliance. Slight fluctuations in the intensity of signals bounced off the balloon support the theory.

However, the 100-ft. sphere still is an excellent reflector. Radar measurements show the surface area to be about the same as on Aug. 12, the day of launch.

Bidding Starts on Minuteman Silos

The 150 *Minuteman* hardened launching sites at Malmstrom AFB, Mont., are to be completed by 1962. Each 10-bird "flight" will function under a single launch control facility. The $40-million complex will have an oxygen generator system and a 5500-gallon water tank at each of the 15 spring-supported underground control centers.

The Army Engineers will open bids about Nov. 3 in Seattle. Completion dates will be issued in the specifications around Sept. 3. A pre-bid conference is scheduled for Oct. 6 in Seattle. Invitations will be circulated only among those contractors whose records of performance guarantee timely completion.

SP Upgraded by Raborn Promotion

Importance of the Navy's *Polaris* program is being raised by the Administration in elevating Special Projects Director William F. Raborn to vice admiral. Upgrading of the billet will not affect SP's organizational setup for contractors.

Zeus Operational Prototype Fired

rst tactical configuration of the Nike-Zeus AICBM launched cently at White Sands, N.M. Missile was ninth fired in devel- ment program. Small grille-like part visible below missile is launching shoe, normally airborne to about 200 ft.

Satellite Weather Forecasts Now Su

Daily worldwide service expected in 4-5 years, depending on funds and rate of technical progress; Tiros II data to be widely distributed

by Jay Holmes

Daily worldwide weather forecasts by satellite now appear certain to become a reality within four to five years. Just how soon is largely a question of money and the rate of experimental progress.

Satellite forecasting—the first practical application to result from man's exploration of space—has already begun. Some data from *Tiros I*, the first weather satellite, was fed into regular weather channels and was available to U.S. meteorologists for 78 days this last spring.

Wider distribution and use will be made of information from *Tiros II*, to be fired later this year.

If R&D progress continues as expected, and if money is forthcoming continually, an operational system of weather satellites may be established in four or five years. The total cost, exclusive of launch vehicles, will be about $60 million.

The great advantage of satellite weather observation is the possibility of complete coverage. At present, weather predictions are based on information from a world network of reporting stations concentrated in the densely populated regions, which make up about a fifth of the earth's surface. Data from the remaining four-fifths of the earth's 6 x 10^{15} tons of atmosphere is sparse or non-existent.

The weatherman is called on to answer many questions, of importance to aviation, shipping, agriculture and a host of industries. Accurate, detailed weather forecasts are obviously vital to national defense. But the question of greatest interest to most people is, "Will it rain or shine tomorrow?"

• **Cloud cover pictures**—To give a reliable answer, the meteorologist must know first where it is raining and shining today. He collects observations—samples describing weather conditions near each of his widely distributed stations. Using these bits of information, he must make up a picture of the weather, relying on experience and inference to fill in the gaps.

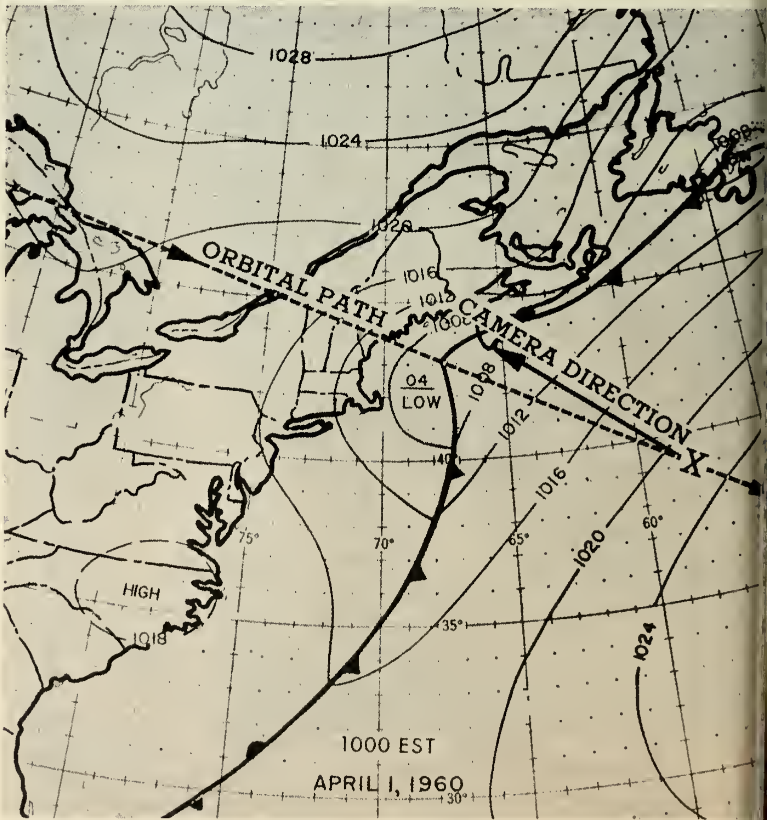
The forecast is a projection of this picture into the future.

But no matter how experienced the weatherman, the picture is still largely guesswork. Weather systems affecting populated areas develop over tremendous stretches of ocean for which there are few reporting stations. The weatherman's only knowledge about what is happening there comes from ships and planes passing through. For great areas off the world shipping lanes, there is no information at all for long periods of time.

This situation is not limited to the oceans. Several years ago, a midsummer deluge of rain poured on parts of New York State, Pennsylvania and lower New England—a highly populated area—causing widespread floods, many deaths and property damage in the millions. There was no warning from the Weather Bureau. The storm originated in an area between reportin stations.

Tiros 1 showed it was possible t photograph the cloud cover and mak maps that show where it is cloudy an where the sun is shining all over th earth. With this information alone, th Weather Bureau and military weathe services were able to make detailed analyses for many ocean areas where th scanty amount of conventional surfac information made accurate depictio of existing weather next to impossible.

• **High performance**—*Tiros* was test craft. Its primary purpose to demonstrate the feasibility of a weather satellite. But in doing so, it turned in series of spectacular accomplishments. some of which were of immediate



TIROS TRAVELED southeastward in its orbit the first day, photographing clou formations over the Great Lakes, the Northeastern U.S. and the Atlantic.

be Reality

alue. The accomplishments included:

–Man's first view of a fully devel-ped tropical storm in one paragraph. South Pacific typhoon, 800 miles in iameter, was observed on *Tiros'* 125th rbit.

–A collection of 22,952 cloud-cover ictures transmitted over a period of 8 days, more than 60% of good uality.

–Special cloud maps supplementing urface-gathered weather data, distrib-ted within three to six hours after the ictures were taken from space.

–Identification from the pictures of area containing cumulonimbus ouds on May 19 that two hours later awned a series of tornadoes and hail-orms on the Oklahoma-Texas line.

When the National Aeronautics and ace Administration launches its sec-d *Tiros* in the last quarter of this lendar year, the information will be d at a greatly increased pace into erational weather channels—even ough the primary function of the sat-lite will again be experimentation. he operational use of the information ill still be considered an experiment— further test and document the opera-nal value of satellite data.

In the area of theory, observations om *Tiros* have already changed some eas meteorologists held about weather ocesses. Beyond this, many questions ve been raised, which will require ngthy study to settle.

• **Money needed**—Strangely, theo-tical meteorologists are far from oded by the thousands of pictures ailable. For even among the thou-nds, there may be only a few of a rticular type of weather situation. obtain proper statistical samplings, searchers hope to have the opportu-ty to study many more such pictures.

The most important of the new eas is the extent and frequency of rge spiral cloud and storm systems. was well known previously that opical hurricanes consist of bands iraling about a quiet center.

Tiros pictures showed that the spiral oud bands occur frequently, over uch larger areas than those of tropi-l storms, and over oceans outside of e tropics.

Another attractive idea is that clouds often are lined up in the direction of the wind—a fact that, if true, would greatly increase the value of cloud-cover photos. Evidence is mixed on this question.

The application of cloud-cover information was so obviously successful that the Weather Bureau immediately began to make plans to exploit it. A short time after the launching, the bureau sought an emergency $5 million appropriation—half for research and development on its use and half for additional communication facilities.

The Budget Bureau turned down the request on the ground that the Weather Bureau should get its funds from NASA, which supports the Weather Bureau work out of its meteorological satellite budget. That fund now has risen to $20.7 million in the current fiscal year.

NASA said it could not supply the communications money because its function is research, not operational weather forecasting. Now, however, the space agency is rethinking the entire question. A top-level study, to be completed by fall, will seek to determine the proper organization of government agencies to coordinate and control all practical uses of space exploration.

Weather Satellites, Present and Future

Satellite	Launch Date	Vehicle	Orbit	Stabilization	Instrumentation
Tiros I	April 1, 1960	Thor-Able	50	Spin	2 TV cameras
Tiros II	4th quarter 1960	Thor-Delta	50	Spin	TV cameras, Earth IR scanning
Tiros III	1961	Thor-Delta	50	Spin	TV cameras, Earth IR scanning
Nimbus I	1st half 1962	Thor-Agenda B	Polar	Earth-oriented	TV cameras, Earth IR direct Solar measurements
Later Numbus, operational versions	1963 or 1964	Thor-Agenda B	Polar	Earth-oriented	TV cameras, Earth IR direct, Solar measurements, Infrared spectrometer Radar
Aeros I	1964 or 1965	Centaur or Saturn	Polar	Earth-oriented	TV cameras, Earth IR direct, IR spectrometer, Solar measurements. Radar

Meanwhile, plans are progressing for future weather satellites. *Tiros I,* launched April 1, carried two television cameras. The letters in the name stand for Television and Infrared Observation Satellite. But the first one carried only the TV cameras, since the infrared equipment could not be perfected on time.

The second *Tiros* will carry infrared instrumentation that will scan the earth's heat radiation, mapping it by area. The first attempt at measurement of heat radiation was aboard *Explorer VII,* which measured total heat flux from the earth.

The second-generation weather satellite, *Nimbus,* will be stabilized so that the TV cameras always point toward the earth. *Tiros* is spin-stabilized; thus the camera is always in motion with respect to earth and pointed away from the earth much of the time. Also, *Nimbus* will be a polar orbiter, which will look at all of the earth. *Tiros I,* with an orbital inclination of 48°, observed only that part of the earth between the two 48th parallels.

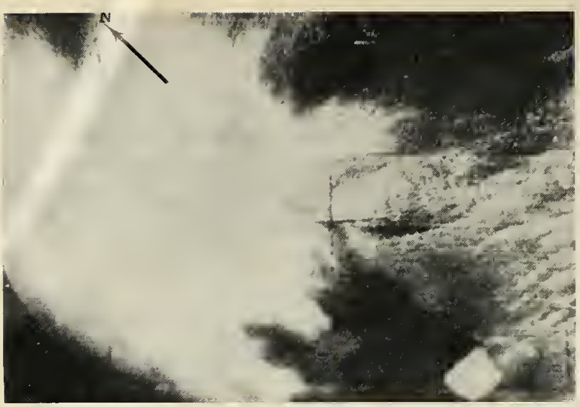
NASA expects to let a contract this fall for development of the *Nimbus* spacecraft. The first one is due to be launched by a *Thor-Agena B* vehicle in the first half of calendar 1962.

Still farther in the future is *Aeros,* a 24-hour satellite, which has not yet been approved. If approved, the project could begin in 1962 and launchings might take place by 1964.

Aeros would provide stationary platforms from which cloud cover and the earth's heat radiation could be measured. In addition, weather scientists are at work on plans for measurement of temperature structure and composition of the atmosphere, the sun's radiation spectrum and precipitation and cloud structure as shown by radar.

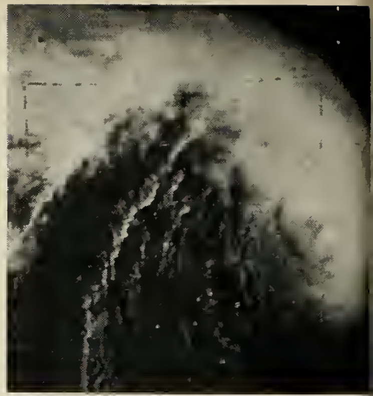
• **History**—No one is certain of the exact origin of the idea of using satellites to improve weather forecasting. One of the first to put it forward seriously was Harry Wexler, the Weather Bureau's director of meteorological research, in a talk in 1954.

Wexler made the suggestion a short time after an *Aerobee* rocket, launched from White Sands, N.M., saw a well developed storm center that was responsible for widespread flash floods in the southwestern United States. The continental network of surface reporting stations, a reasonably dense network



LEFT: Square white patch is cloud mass that spawned tornadoes over Texas May 19.

RIGHT: Typhoon 1000 miles east of Australia, snapped April 19.



in comparison with the ocean areas, gave no indication of the impending storm.

The *Tiros* project began in the Advanced Research Projects Agency of the Department of Defense and was transferred to NASA in the spring of 1959. All three services, however, still are participating. The Army Signal Research and Development Laboratories at Ft. Monmouth, N.J., supervised development of the payload and some ground equipment by RCA's Astro-Electronic Products Division. The Air Force and its contractors supplied the launch vehicle and facilities, data acquisition and help in data analysis and interpretation. The Navy helped process and analyze the photographs.

The Weather Bureau had the responsibility for data analysis, interpretation and dissemination.

The 270-lb. *Tiros I*, a stubby cylinder 19 in. high and 42 in. in diameter, carried beacon transmitters, attitude sensors, telemetry circuits and a 19-watt power pack of nickel-cadmium batteries charged by solar cells, in addition to the TV cameras and related equipment.

A wide-angle TV camera covered an area of about 1000 miles on a side at the satellite's average altitude of 450 miles. A narrow-angle camera covered an area of 100 miles on a side within the wide-angle camera's view. The cameras each consist of a lens, a focal-plane shutter and a ½-in. Vidicon tube especially designed for satellite use.

An electron beam converted the stored picture into an electronic signal that was transmitted directly to ground receivers or stored in a magnetic tape recorder for later transmission. When out of ground station range, the tape recorders attached to the two cameras could store up to 32 pictures.

• **Identification tough**—The satellite, spinning at a rate of between 9 and 12 rpm, could be programed to take pictures at 10-second or 30-second intervals. The wide angle camera had an f/1.5 lens and the narrow angle lens was f/1.8. Each had a shutter speed of 1.5 milliseconds.

Two primary ground stations commanded the satellite and received photo data. They were at Ft. Monmouth and Kaena Pt., Hawaii. Backup receiving stations were at Cape Canaveral and Princeton, N.J.

A 2-watt FM transmitter, operating at 235 megacycles, transmitted the stored photographs, from one camera at a time. Tape readout from both cameras took about 3½ minutes. Since *Tiros* was in transmission range of a station up to 12 minutes on a pass, it could send 8 minutes of direct data.

Identification of the pictures was a tricky job. Crude approximations were made by identifying landmarks on the wide-angle lens. Next, a process of "boot-strapping" was followed, in which cloud elements were matched in successive pictures, until another recognizable landmark provided a second reference point.

Many problems had to be solved to match each picture with the latitude and longitude grid. The wide-angle lens gives a barreling effect. The images were distorted by imperfections in the electrical signal. The image was foreshortened whenever the lens was not pointed exactly perpendicular to the earth's surface—nearly all the time on a spinning satellite.

The first few matching grids took weeks to draw. However, an IBM 7090 computer and a high-speed curve drawer supplied by Electronic Associates, both at the Weather Bureau's National Meteorological Center in Suitland, Md., are helping to produce the remaining grids at a rapid rate.

Cloud-cover maps, produced from the *Tiros* photos as a supplement to weather maps, are being put together in animated form by Navy weathermen as an aid to studying the dynamics of the atmosphere.

• **Meteorological gains**—The pictures showed a tremendous degree of organization of the cloud patterns over the earth.

The *Tiros* pictures have provided views of spiral cloud formations of all sizes—large, small and middle-sized—and of all ages—from a storm just developing to one gradually breaking up. They will provide objects of study for researchers for years to come.

The Weather Bureau is building up a staff of about 80 to make theoretical analyses of the pictures and other data to be gathered by future weather satellites. Present employment in the bureau's Meteorological Satellite Section totals about 45.

Jobs are open for synoptic meteorologists, theoretical meteorologists physicists and electronic physicists a the National Meteorological Center i Suitland. Starting salaries range fro $5880 for recent recipients of bachelor' degrees to $10,635 (G. S. 13) for Ph D.'s or others with appropriate researc experience. A few higher-salaried post are open to persons with heavy ex perience.

• **Future plans**—On *Tiros II*, loca radiation intensity will be mapped ou with the aid of the satellite's spin. A it moves in orbit, *Tiros* will point it IR detector toward the earth. The spi will create a scan, like a single lin traced by the scanner in a TV pictur tube. The spin will point the detecto out to space for a moment. When i returns to earth, the orbital motion wil have carried the satellite to a ne location. Thus the series of lines wil trace out a television-type picture o the earth's relative heat radiation.

Heat mapping will fill an importan role in operational weather forecastin through theoretical study of weathe processes. The atmosphere is a grea heat engine. More exact knowledge o what happens will fill gaping holes i the weatherman's understanding o what happens.

If *Tiros II* proves the heat-mappin system feasible, it and cloud-cover pho tography will be incorporated into th earth-stabilized, polar-orbiting *Nimbu* Although several other weather exper ments are in the study stage, probabl ione will be ready by the time the first *Vimbus* is launched. The big assignnent for *Nimbus I* will be to prove out technique for the difficult job of keepng cameras and detectors always ointed straight down.

Nimbus has slipped a little. Until ecently, it was scheduled to be aunched in the fourth quarter of 1961. Now, the target date is the first half f 1962.

A 650-lb. satellite, *Nimbus* is to be ired into a retrograde orbit of 80° nclination at an altitude of about 1000 ilometers (621 miles). It will have hree subsystems: an electrostatic tape amera, high and medium resolution nfrared equipment and a number of arth-sun experiments.

On Sept. 2, NASA's Goddard Space light Center received industry bids on lesign, development, construction and esting of a command interrogation deice for *Nimbus*. The contract, which is xpected to be awarded in a month or wo, will call for a one-month design tudy, delivery of one prototype eight nonths after start of work, a second rototype two months later, and a flight nodel 13 months after the start of work. Three more flight models are to be lelivered in the next three months.

The flight model thus could not be lelivered sooner than November 1961. This factor alone might have pushed he launch date back to 1962.

Another factor is that the prime ontract on *Nimbus* has not been warded. NASA expects to request bids n the system shortly.

A pair of *Nimbus*-type satellites ould provide data for a single global veather data and forecasting center, stronautical scientists were told last nonth in Stockholm.

• **Global system**—In a paper given t the Eleventh Annual Congress of he International Astronautical Federaion, R. P. Haviland of General Elecric said global coverage could be obained with two mutually perpendicular olar orbits at altitudes of 2000 to 000 miles. The single data and foreasting center could be located almost nywhere. However, a polar site where eadout could be obtained on every assage would be best, he said.

Later versions of *Nimbus* will have everal more advanced forms of intrumentation. It is hard to predict which will come first. Some scientists hink radar may develop swiftly. The viation industry is tremendously enhusiastic about the success of airborne adar in spotting weather disturbances nd helping pilots steer around stormy reas.

Radar sees bad weather by observng reflections from the falling rainlrops. The same equipment in a satelite could spot and follow storms long efore they came within range of airborne radar. It would operate night and day, unlike cloud-cover photography. Also, the cloud photo does not say whether rain is actually falling.

The satellite-borne radar might be used in conjunction with a network of ground radar beacons connected to automatic weather stations.

Another form of future instrumentation is an infrared spectrometer. The Weather Bureau has seized with considerable enthusiasm a suggestion by L. D. Kaplan of Massachusetts Institute of Technology that radiation by carbon dioxide in the 15-micron IR band might make it possible to measure temperatures at various levels of the atmosphere.

Kaplan assumed that CO_2 is uniformly mixed through the atmosphere and that the mixing rate is known. From 10 measurements of radiation at different wavelengths in the 15-micron bands, he suggested setting up a set of simultaneous equations that would yield 10 temperatures.

By selecting wavelength intervals according to the absorption of CO_2, he argued, it might be possible to obtain a vertical temperature sounding that would have nearly the accuracy of those obtained with radiosonde balloons.

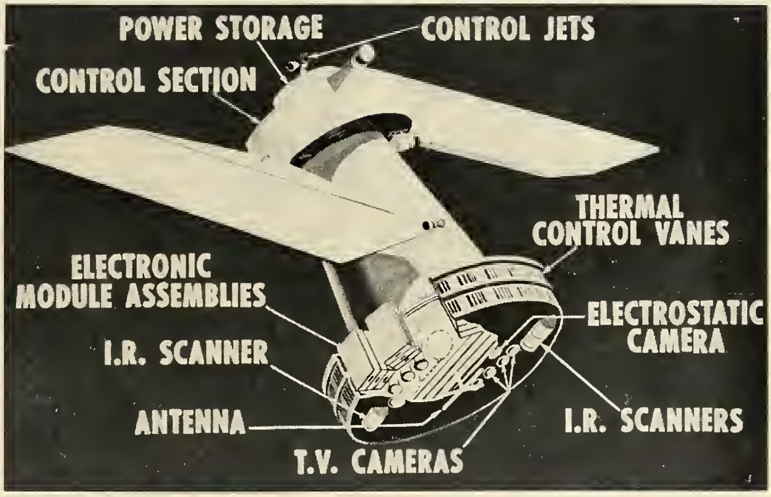
The Weather Bureau is using a simplified form of the Kaplan scheme in which three layers instead of 10, all in the stratosphere, are used. This will avoid the problem of interference from clouds lower down.

• **IR experiments**—A second similar experiment would measure the temperature at the surface of the earth at any given point, where clouds are absent. This would be done by measuring IR radiation in the 11.1 micron region, a "window" through which at least 70% of the IR radiation gets through the entire atmosphere.

In June, the Weather Bureau awarded an $80,000 contract to Barnes Engineering for a nine-month design study of feasibility and instrumentation for the two IR spectrometer experiments. Specifications called for limitation of instrument size to 6 cu. ft. and total weight to 300 lbs. Power requirements must be held to 10 watts.

The specifications described flight conditions that indicated the spectrometer experiments are contemplated for use in later versions of *Nimbus*. The conditions are: stabilization, so that one axis is perpendicular to the earth's surface, and a speed of about 4 miles a second in a circular, quasi-polar orbit at 600 miles altitude.

Besides getting accurate, detailed measurement of the heat given off by the earth, the weatherman must also know in detail the amount of energy the earth receives from the sun. A number of the earth satellites have made measurements of the sun's radiation. Eventually, however, a permanent monitor of solar activity will be needed.



NASA artist's conception of the second-generation Nimbus weather satellite.

The later versions of *Nimbus* probably will put all the measurements together on a permanent basis.

Beyond *Nimbus*, NASA and the Weather Bureau are now considering the possibility of a big 24-hour satellite called *Aeros*, which would provide the advantage of weather observation from a platform that would be completely stationary with respect to the earth. The time period projected for the first launching, about 1964, would indicate that *Atlas-Centaur* is contemplated as the launch vehicle.

Centaur, however, is limited in the weight of payload it could deliver and guide precisely to a 23,000-mile orbit over the equator. If *Aeros* is approved, it may have to wait a year or so and become the first major assignment for *Saturn*.

Atlantic-based subs available . . .

Pacific Fleet Must Wait for Polaris

FBM submarines are several years from deployment there; Mace and Regulus I are biggest missiles now in Far East arsenal

by Frank G. McGuire

PEARL HARBOR, HAWAII—Deployment of *Polaris* submarines as part of the U.S. Pacific Fleet appears to be about three or more years away under present plans.

However, this would not mean that Atlantic-based *Polaris* subs would necessarily avoid Pacific waters while on station—particularly as the size of the *Polaris* fleet increases.

Polaris submarines operating out of East Coast ports are capable of cruising anywhere off the coasts of the Sino-Soviet Bloc.

But officially the biggest U.S. missiles deployed in the Pacific under the Pacific unified command are *Regulus I* and *Mace.*

Missiles in the CINCPAC (Commander in Chief, Pacific Unified Command) arsenal are based on Okinawa and Taiwan and in Korea.

Nuclear-armed *Honest John* surface-to-surface missiles are in use by the 4th Army Missile Command in Korea. *Nike-Hercules* antiaircraft missiles with nuclear warheads are on Taiwan and Okinawa, with deployment in Korea expected soon.

Hawk antiaircraft missiles are expected to be deployed with several battalions on Okinawa and in Korea by the End of this year. Nuclear-tipped *Mace* missiles are now located at Tainan on Taiwan and at Kunsan in Korea.

• **Seagoing missiles**—At sea, the Pacific fleet's 425 ships include five missile-launching submarines—USS Halibut, Tunny, Grayback, Growler and Barbero—armed with *Regulus I* air-breathing surface-to-surface missiles. In addition, four missile-armed cruisers are in the fleet—USS Helena and Los Angeles, both with *Regulus I,* and the USS Topeka and Providence with *Terrier* antiaircraft missiles.

Three more cruisers, the USS Galveston, Chicago and Oklahoma City, will soon report to the Pacific fleet with *Talos* antiaircraft missiles. A frigate, the USS Preble, with *Terrier,* is now with the fleet and will soon be joined by the frigates Coontz, King and Mahan, now under construction.

Four nuclear submarines—USS Sargo, Swordfish, Halibut and Sea Dragon are with the fleet, and believed armed with nuclear torpedos, presumably *Astor,* an antisubmarine weapor A fire aboard the Sargo some month back brought out a report that nuclea warheads were on its torpedoes. Nav spokesmen here confirmed the repor initially, then an official headquarter denial was issued. Navy has since refused comment.

With fleet air units are *Bullpu* *Sparrow* and *Sidewinder* missiles, a well as Lulu nuclear depth charge Aircraft operational currently are th A3D, A4D, F3H, F8U, and WF2.

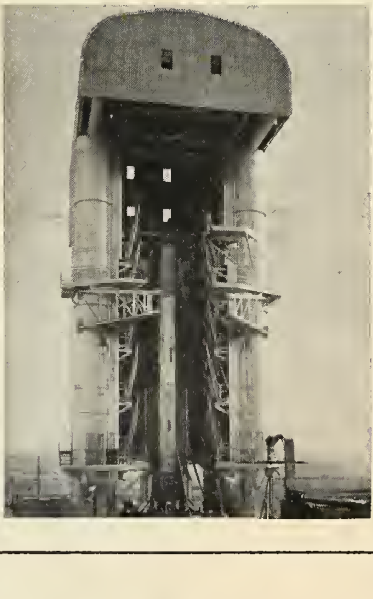
• **Growing opposition**—On the opposing side of the Bamboo Curtai CINCPAC spokesmen disclaim an knowledge of either missiles or nuclea weapons in Korea, but carefully poir out that such capability may be there In the remainder of Communist-cor trolled Asia, missiles are coming int operational arsenals in increasing numbers.

Giving an estimate of Communis air strength throughout Asia, Maj. Ge C. W. Cecil, Deputy Chief of Staff f Pacific Air Forces (PACAF) said total of 6300 operational combat ai craft face the Western Powers in th Pacific area, in addition to support ai craft. Of this total, 3200 are Sovie 2600 are Chinese Communist, and th remainder are North Korean.

PACAF intelligence believes tha the Soviets have one of their three long range air armies in Far Eastern Russia with major bases at Vladivostok, Irkuts and west of Komsomolsk. Bear an Bison aircraft make up this force. Additionally, tactical aircraft of the Il-1 Beagle type are based in the Sovi Maritime provinces, as well as Nav Air Forces, which utilize the Il-18 als but are land based units.

The Il-18 (of which there a 1000) can cover all of Southeast Asi Japan, Okinawa and Philippines fro bases in China. The estimated 200 Biso and Bear bombers can cover all of th Pacific area from home bases with on aerial refueling.

Besides the Bear, Bison and Beagle Russia is credited with the deploymer of about 3260 day fighters and 24 all-weather interceptors in its air defense setup.

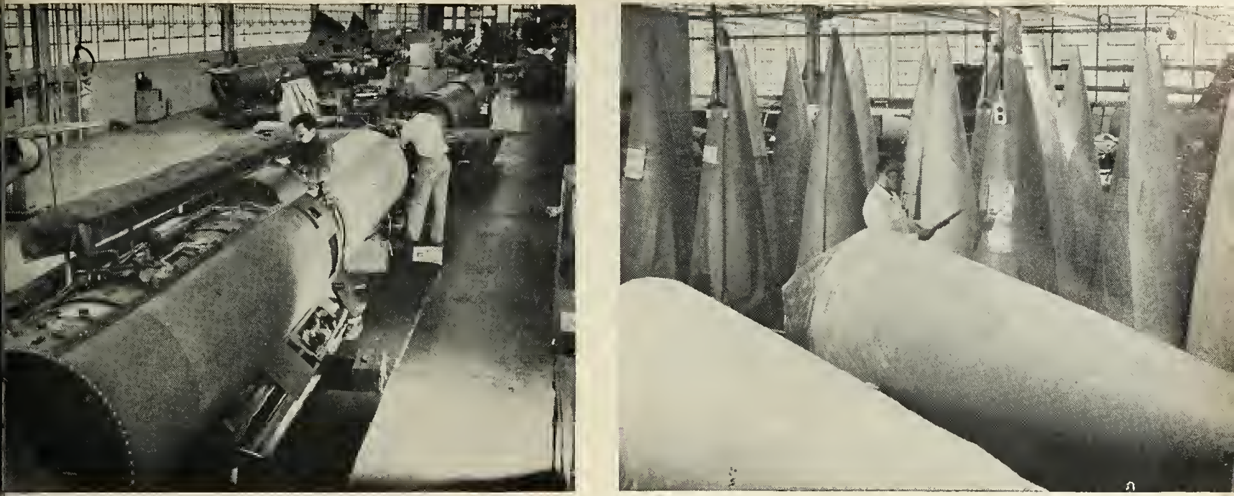


Next Week . . .
Third Annual GSE Issue

The era of big missile mobility is at hand.

For next week's special issue, M/R editors have compiled a provocative report on the impact of mobility upon ground support equipment; what it means in terms of strategy and the immediate and future requirements of the military services.

Among the many special features in this latest GSE issue will be an inspection of Spadeadam Rocket Establishment (see photo), Britain's most important missile center, whose future hangs on whether the British decide to proceed with a space program.



Bomarc B Production Line

IRST PHOTOS of Boeing's Bomarc B final assembly at attle. Moving along line at rear are now-operational Bomarc 's. Mating of nose radomes (right) is included in final assembly. Almost scrapped by Congress this year, Bomarc B experimental models recently have hit targets at up to 270 miles. The supersonic interceptor will be deployed in U.S. and Canada.

cout Shot Soon

Second Four-Stage Launch Due in a Month

WALLOPS ISLAND, VA.—A second ring of the full four-stage *Scout* satel- te launcher will take place in about a onth from the National Aeronautics id Space Administration station here.

Engineers are making changes in e bird and in ground support equip- ent to take account of weaknesses otlighted by the aborted first flight ily 1.

Thrust of the hydrogen peroxide ts used for roll control of the third age was more than doubled. On July excessive torque overpowered the ntrol jets just at third-stage burnout.

The heat shield on the third stage as restructured. The shield came off the first flight as the vehicle passed rough the transonic region during st-stage burning. Normally, the shield jettisoned at third-stage ignition.

The launching will be controlled om a new blockhouse just completed tween the *Scout* and *Little Joe* unching pads here. Workmen now are stalling control and tracking equip- ent.

• **Tracking insurance**—The *Scout* ill be tracked optically as well as by dar. John C. Palmer, chief of flight st operations, said it is hoped that tical tracking will prevent an errone- is radar reading, which was respon- ble for the abort on July 1. The radar ve a signal that appeared to indicate e vehicle was veering off course dur- g third-stage burning.

Actually, it was on course. How- ver, the ignition of the fourth stage was prevented by command signal. As a result, the *Scout* reached an altitude of only 860 miles and traveled only 1500 miles downrange. The four-stage flight program had called for reaching 2300 miles altitude traveling 4700 miles downrange.

NASA's contract with Chance Vought calls for firing of three more *Scout* vehicles before next July 1.

AF Hunts More Space For West Coast Work

INGLEWOOD, CALIF.—Employment at the USAF missile division and allied space programs will jump 600% in the next 4-5 years—reaching a total of 12,000 employees.

In the next 24 months alone, the present employment figure of 2000 persons is expected to increase to nearly 8000.

Air Force officials now term the search for additional working space "urgent." Already overflowing their present facility at Inglewood, Calif., the Ballistic Missile Division and Ballistic Missile Center are looking for a several-hundred-acre plot in Southern California.

Plans formulated in June for the purchase of Space Technology Laboratories quarters are already being tabbed "inadequate." Studies show that the STL facility would be too small.

Although the STL plant could house 3000 persons, preliminary plans call for BMD, BMC, STL and the new Aerospace Corp. to share it jointly. Projected 24 month growth rates for these groups are: BMC, from 600 to 2400 persons; BMD, 1000 to 2000; Aerospace Corp., 100 to 3000.

Plasma Modulation Study

(Cover Story)

It is possible to transfer information through the plasma sheath enveloping a re-entry vehicle, according to preliminary results of tests currently being performed by Melpar, Inc., Falls Church, Va.

Under certain conditions, a portion of the plasma can be modulated in density. Since a variation in cross-section occurs, the company says that even a modest radar system can detect the change and record the modulation waveform.

If the plasma is over-dense for a particular radar frequency, and if the wavelength and plasma scale height are related properly, reflectivity is very high.

Melpar is investigating the combined plasma physics-electromagnetic boundary value problem in detail. In its experiments, a plasma modulation tube (see cover picture) is being used to help verify the Melpar theory of data transfer through a plasma sheath.

Coils on the tube "ears" produce the main plasma. The central Vycor coil modulates plasma density. A focused-microwave plasma-diagnostic system is employed to measure reflected power variations. The two double probes shown in the picture are used to measure electron density and temperature at different radial points within the plasma.

Neon is used in the tests to expedite the theoretical and experimental correlation of results, largely because of the well-behaved cross-section of the gas as a function of electron energy.

SAC FLEXES A NEW MUSCLE

Beneath the wings of its B-52 intercontinental bombers SAC now packs a formidable new weapon—the GAM-77 HOUND DOG air-to-surface missile. The first operational unit to carry the supersonic HOUND DOG is the 4135th Strategic Wing, based at Eglin Air Force Base, Florida.

This B-52/GAM-77 union greatly extends the useful life and striking power of SAC's long range bombers and adds to the command's operational flexibility.

The HOUND DOG's versatile capabilities have been demonstrated in a number of free flights over the Atlantic Missile Range and the Eglin Gulf Test Range. In addition, it has withstood many extreme environmental tests including a 10,800 mile flight over the North Pole ending with a successful firing over AMR.

In just 30 months, the HOUND DOG air-to-surface missile progressed from the drawing board to its first flights with SAC crews. Combined with the B-52 bomber, the HOUND DOG gives SAC a powerful new deterrent for preserving world peace.

THE MISSILE DIVISION OF NORTH AMERICAN AVIATION, INC.

Downey, California

Technical Countdown

PROPULSION

Answer to Solid-Propellant Mystery?

An explanation of why erratic variations in temperatures and pressures result from acoustic resonance during burning may soon be at hand. According to Dr. Frank McClure of Applied Physics Laboratory, pressure transducers able to live in the 5000°F combustion temperatures are just becoming available and can be expected to help shed some light on the problem—one of the most critical in solid-propellant technology.

Propellant Design Ups Minuteman Mass-Fraction

Secret of the *Minuteman* booster's mass-fraction of 0.89—best for any big solid rocket—is a combination internal configuration that eliminates tail-off burning of residual silver. The boundary between slow-burning and fast-burning propellant is designed so that the flame reaches all sections of the outer case simultaneously.

New Saturn Booster Tests Slated

The next series of *Saturn* static tests, beginning at Huntsville late this month or next, will simulate the actual flight configuration of the giant booster. The tail section will be completely enclosed so that eventual leakages will show up. A tail shroud, tail flame shield, and tail heat shield will be added to the SAT prototype tested in last spring's series. Last tests demonstrated that each of the eight engines behaves as if it were operating completely on its own.

ELECTRONICS

Space Surveillance Improvement Drive

There's widespread feeling that the U.S. must develop a more effective space surveillance system. ARPA—which is getting out of management side—will continue to pursue R&D. Primary needs are methods for identifying detected satellites and longer range (over 1000 miles) capability.

Project PRESS Gets Under Way

ARPA has started work on Project *PRESS* (Pacific Range Electromagnetic Signature Study) aimed at detection and identification of ballistic missile warheads. Part of Project *Defender, PRESS* is a more sophisticated version of the current DAMP study being conducted at Atlantic Missile Range.

Pyrogyro Powered by Tiny Charge

A pryotechnic gyroscope developed by Giannini Controls uses a three-gram explosive charge in the hermetically sealed unit to drive its rotors. The propellant is ignited electrically. Gases escape through tiny holes to provide a jet-like impulse which drives rotor up to 36,000 rpm within one-tenth second after ignition. Running time for the half-pound gyro is four minutes.

New Cryogenic Phenomena Observed

Scientists at Varian Associates are attempting to predict and measure plasma effects under conditions which apply in a solid-state material. Most work is done at liquid-helium temperatures. Varian is believed to be first to attempt a thorough exploration of plasma effects in semiconductors.

EIA Hits Lower Electronic Tariffs

Electronic Industries Association has gone on record against tariff negotiations aimed at cutting duties on any electronic products. In support of its opposition, EIA declared that lowering import bars would cause "deterioration, rather than technological progress, in our military programs."

Radio Signal Super-Detector Developed

A new adaptive waveform recognition system for detecting and classifying unknown or concealed radio signals has been developed by General Electric Research Laboratory. The system has reportedly detected signals buried in random noise that defied detection by trained observers. According to GE, the system's operation is limited to narrow-band signals and would not be a counter to a noise communication system such as GE's recently announced "Phantom" (M/R, Sept. 5, 1960).

ADVANCED MATERIALS

Meteoroid Protection by Bumpers

Spacecraft weight reductions up to 50% in outer-wall construction can be achieved through meteroid bumpers or multi-wall configurations. Tests at GE's MSVD show that a large part of a meteoroid's kinetic energy can be dissipated, resulting in only a mild pitting of a vehicle's skin. Test pellets reached velocities of 18,800 ft/sec.

Research in Rolled Beryllium

In an effort to reduce the cost of end parts, the Air Force is spending about $300,000 on an R&D program for rolled beryllium structural shapes. Beryllium Corp. will perform the basic studies, while certain phases of the program will be carried out by Allegheny Ludlum, The Budd Co., and Nuclear Metals.

Ceramic-like Resins Still in Early Development

Latest word from the British firm, Artrite Resins, is that their ceramic-like resins (Technical Countdown, June 6, 1960) have not yet been developed sufficiently to warrant announcing availability, price, or even a trade name.

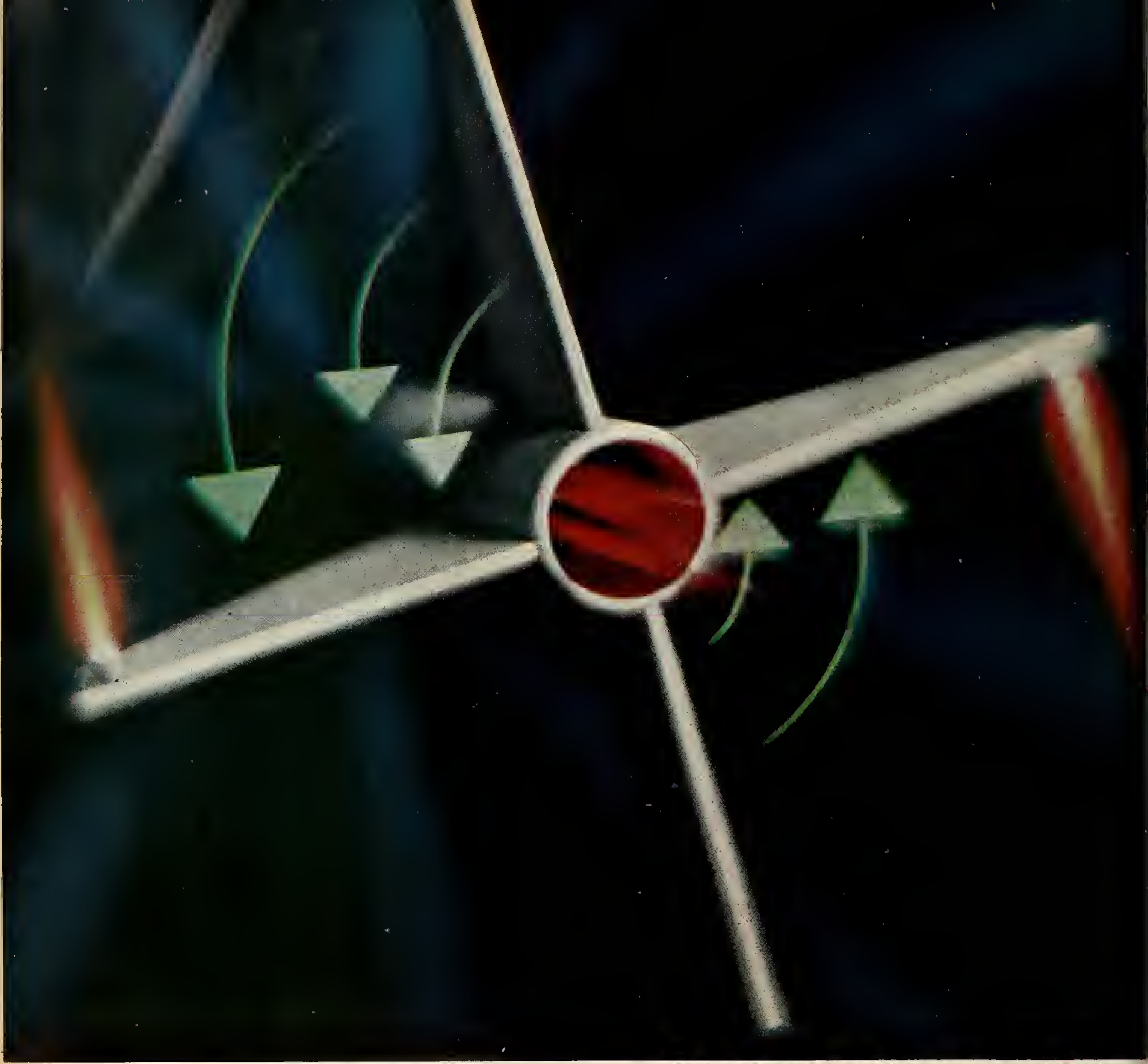
Latest on Boron

Decaborane and pentaborane are available in lab quantities from Olin Mathieson's Energy Division . . . Callery Chemical reached an agreement with Imperial Chemical Industries Ltd. for an exchange of assessment information in certain aspects of the field of boron compounds. Acquisition by either party of non-exclusive royalty-bearing licenses under the other's patents is one aim of the pact.

ASW ENGINEERING

ASW Almost Limitless Area

A Naval Ordnance Laboratory study shows that there are about 1500 different ASW operational situations—based on the wide variety of vehicles, locations, threats, types of war, and tactics.



Reaction controls at work in space — symbolized.

STEERING GEAR FOR ASTRONAUTS

Conventional aircraft control surfaces will not guide space ships and capsules. Rudders, ailerons and elevators find no resistance and hence produce no reaction to their movements where there is no atmosphere. Even at altitudes only half way up, they are sluggishly ineffective.

The accepted answer to a dependable steering mechanism for astronauts is a system of jet reaction controls developed and produced by Bell Aerosystems Company. First used on Bell's own supersonic X-1B several years ago, the system has been greatly improved and adopted for the X-15, the Mercury man-in-space project and other space vehicles.

Through strategically located, low and high thrust (1 to 1500 pound) rocket engines, Bell's reaction controls not only position and guide the ship by controlling the roll, pitch and yaw, but they also provide for orbit changes and retro-thrust. Some of the jets are throttleable while others can be operated in combination to provide the astronaut positive and flexible control.

This revolutionary steering gear for space, available using monopropellants or high energy bipropellants, is just one of many advanced projects which are currently engaging the diversified talents of Bell Aerosystems Company in the fields of rocketry, avionics and space techniques. Engineers and scientists seeking challenging, long-range career opportunities can find them at Bell.

BELL AEROSYSTEMS COMPANY
BUFFALO 5, N. Y.
DIVISION OF BELL AEROSPACE CORPORATION
Successor to the Defense Group of Bell Aircraft Corporation

advanced materials

Tungsten Nozzles by Vapor Deposit

NBS develops method using hexafluoride which makes complex parts easily and cheaply; missile company in the act

by **William Beller**

TUNGSTEN NOZZLES can now be made easily and cheaply through a process recently disclosed by the National Bureau of Standards.

The vapor deposition method is used.

This means that the excellent high-temperature strength of tungsten can at last be exploited for making highly complex parts.

Although the process is still in its early developmental stage, at least one large missile company is hastening to try it for major work.

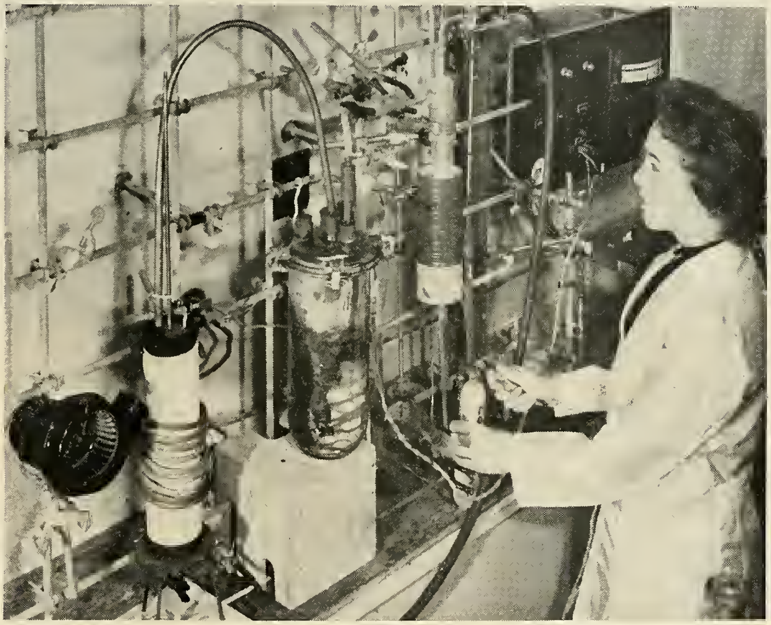
Here is the way the job is done: A mold of the part to be made is first preheated inductively to about 1200°F in a hydrogen atmosphere. Then the gases tungsten hexafluoride (WF_6) and hydrogen are passed over the mold. The result is a tungsten coating deposited on the heated surface while hydrogen fluoride passes off as a waste gas.

The hexafluoride is commercially available and costs only about $25 per pound. The tungsten coating formed by it has a density of 19.3 gm/sq cm—the theoretical density of the pure metal.

This density is higher than that of tungsten compacts made by powder metallurgy or flame spraying methods. Reason is that pores are introduced by these two methods but not by the gas deposition one.

Deposits up to 1/8-in. thick have already been obtained. A 1/16-in. coating was made in one hour—a speedy job, especially when compared with conventional electroplating.

- **An unruly metal**—Tungsten has only recently been put to high-temperature use in forms other than wire and strip. Unhappily, the metal's brittleness and hardness have prevented its being machined by conventional means. Only during the past two years have forging and skull casting techniques been successful. Thus, strong efforts have been going on to get a practical way to deposit tungsten coatings.



TUNGSTEN-PLATING PROCESS takes place in ceramic cylinder shown at left. Waste gases are absorbed in center vessel. NBS chemist Jean Connor monitors process.

Tungsten deposition from aqueous or organic solutions was tried unsuccessfully. An effort was made to release the metal from fused electrolytes. The rate of plating was too slow, the deposit too rough, and the coatings could not be built up to the desired thickness.

Vapor phase deposition was then tried. An early chemical used, and one that is still being experimented with, is tungsten hexachloride (WCl_6).

The hexachloride is a solid and therefore has to be vaporized—an unwelcome complication. Also, the plating process is highly sensitive to the rate of WCl_6 flow and requires a mold heated to 1740°F. This temperature is above the service point of most steels.

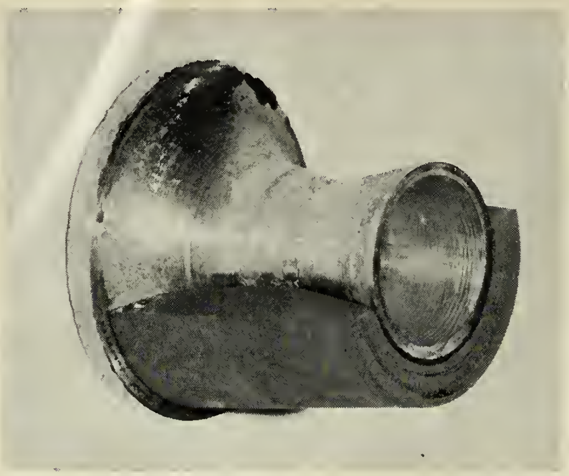
Bureau scientists turned to the hexafluoride for two reasons: (1) The compound is a gas at room temperature. (2) Tungsten readily forms only one compound with fluorine, the hexafluoride. Thus the chemical reaction during deposition is straightforward, uncomplicated by side reactions, and makes highly efficient use of the metallic gas.

W. E. Reid and Dr. A. Brenner of NBS's electrodeposition group devised the present method. The work is being sponsored by the Navy. Coincidentally, a similar method has been developed by the Bureau of Mines.

An industrial organization, still secretive about its pilot plant process of depositing tungsten, is also believed to be using the hexafluoride method.

- **Technique can be crude**—The process is simple enough to be done in most laboratories. The object to be plated is put inside a ceramic cylinder, the air is pumped out and replaced by hydrogen. A controlled temperature induction furnace heats the object to

← Circle No. 6 on Subscriber Service Card.



TUNGSTEN ELZZON (nozzle insert) made by vapor deposition process is shown full-scale. High - temperature problems are lessened by housing in loosely fitting graphite blocks.

1200°F. Then two gases, tungsten hexafluoride and hydrogen, are passed through ordinary flow meters into the reaction chamber.

When the gas mixture contacts the heated object, the reaction leaves a tungsten coating on its surface. At the same time, hydrogen fluoride gas is formed and subsequently absorbed in a metal cylinder containing sodium fluoride.

Reid and Brenner report that although the theoretical ratio of three moles of hydrogen to one mole of hexafluoride is needed for complete reduction, satisfactory coatings are obtained when the ratio is lower. In practice, smooth coatings are insured by using a hydrogen-to-hexafluoride ratio greater than six.

Wide variations in the system have no major effects either on the process' efficiency or on the coating's quality. Although the optimum temperature range for rapid formation of smooth deposits is between 1200° and 1300°F, temperatures in the range from 700° to nearly 1650°F are all effective. At 1650°F, definite crystal growth is observed.

• **Made-to-order thicknesses**—Bonding of tungsten to various materials was studied. Adhesion to molybdenum and to nickel shows up good; to copper, somewhat weaker; and to iron, rather poor. The tungsten-graphite bond is about as strong as the graphite itself. Tungsten deposited on ceramics also displays good bonding characteristics.

To obtain a stronger bond to graphite, Reid and Brenner decided to siliconize the surface. Here in effect, a silicon carbide film was first formed on the graphite. Improvement in the adhesion of the subsequent tungsten coating resulted.

One such tungsten-plated graphite nozzle has withstood a 35-sec. firing test. More rigorous tests are being planned. In addition, preliminary experiments with vapor deposition of the metal rhenium have begun at NBS.

Under good conditions, tungsten can be deposited up to a mil a minute. Thus the process lends itself to continuous production of tungsten-coated strips and wires.

Although plating a metal strip or wire is simple, the uniform distribution of tungsten over an irregularly shaped object is a problem that must be individually solved.

Experiments show that a more uniform thickness of coating is obtained if the plating chamber is much larger than the object. Furthermore; the metal is deposited in greatest thickness where the gas mixture first contacts the object. Hence, coating thicknesses can be appropriately distributed by passing one gas, say WF_6, through the main opening in the chamber; and at the same time, by directing the other gas by means of a system of injector tubes and spouts to the desired places on the object.

The maximum thickness of deposit that can be obtained by this vapor deposition method has yet to be determined. If there is a limitation, it is probably brought about by the maximum allowable roughness of the plated surface.

• **'Elzzons' held by graphite**—Sometimes a pure tungsten part is wanted. In this event, the metal shape that took the initial deposition is dissolved in a suitable acid.

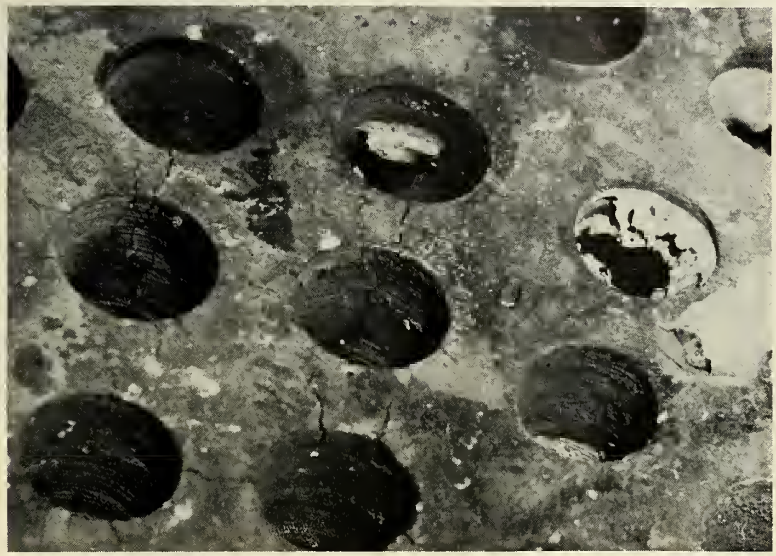
This process is used for making nozzle inserts, which are subsequently housed in loosely fitting graphite blocks. It is believed that this technique for engaging the inserts cuts down on thermal shock problems; it also eliminates the differential expansion trouble that could exist between the tungsten and its substrate metal or graphite under high-temperature conditions.

Probably influenced by Samuel Butler's book *Erewhon*, the NBS scientists have dubbed such an insert an "elzzon," which is "nozzle" spelled backwards.

The high value of tungsten as a structural material for high-temperature use and the simplicity and cheapness of the hexafluoride process will probably bring a number of companies into the tungsten plating field. Meanwhile, the NBS group is studying the crystal structure of the deposited tungsten and the means for altering it to get increased strength and less stress.

SPECIMENS OF simple and complex forms and coated objects produced at NBS. Note plated rocket nozzle (right bottom) and thick solid-tungsten cap (right center).

LiH Studied as Hydrogen Generator



ACCUMULATED OPERATING time of one hour resulted in these cracks in a plate of type 304 stainless steel contained in the lithium hydride system.

FEASIBILITY STUDIES on the production of hydrogen from lithium hydride for a number of space uses are under way at Tapco Group's Test Center, Roanoke, Va.

The lithium hydride work was started because of its potential as a hydrogen producer—one pound of pure hydrogen for every four pounds of lithium hydride. This capability has been demonstrated experimentally.

There are a number of applications for such a generator. Underwater propulsion devices, deep space probes and portable power supplies for ground use are among those being considered.

According to Tapco, the hydrogen would be used with an oxidizer which could be either compressed or liquid oxygen. The energy conversion mode would be either a turbine or a fuel cell.

• **High thermal energy**—The main advantage of such a system is in the large quantity of heat released in the reaction—25,590 cal/gm-mole if all of the hydride is converted to hydrogen. If an adequate supply of water is available and the hydride is converted only to the oxide, the amount of H_2 produced is not affected but the heat quantity drops to 15,600 cal/gm-mole.

In order to utilize the LiH most effectively, it is necessary to re-circulate the water—which results in combustion of hydrogen with oxygen. In a system this means that the steam generated in passing through the system must be pumped back up to the pressure encountered in the hydrogen generator inlet.

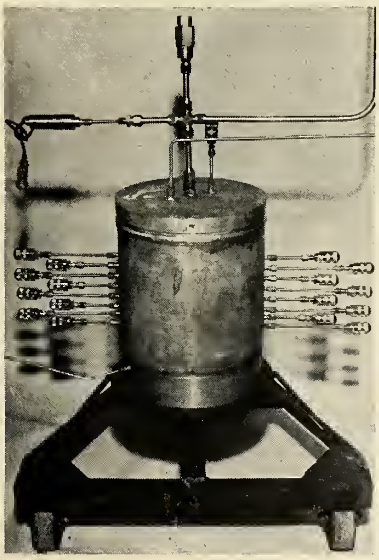
With hydrogen-oxygen fuel cells, removal of the water from the cell with a pump would require an electric motor drive. Reuse of the water to generate more hydrogen greatly reduces the water of the overall system.

Tapco points out that this hydrogen production method is not to be regarded as a panacea for the problems in either carrying bottled pressurized hydrogen or in cryogenic storage. As in most applications, there are certain systems in which the use of LiH is attractive.

The use of LiH with water is not a new application. Balloons have been filled through this means for years. The major hurdle is the generation of H_2 in large volume at high pressure.

Generators have been built at Tapco-Roanoke which produce hydrogen at pressures from 500 to 1500 psi. One large feasibility generator has been successfully operated with a hydrogen production rate of 12 lbs. per hour.

Techniques of control have been worked out and methods of restricting the maximum temperatures within the generator have been devised. Such temperatures may vary from 1700°F to around 3200°F.



LARGE LITHIUM HYDRIDE HYDROGEN generator can turn out 12 pounds of pure hydrogen per hour. The feasibility device is 12 in. in diameter.

The method of starting the generator is probably the most difficult aspect of the operation and Tapco considers this proprietary.

Particle size, chamber configuration, response times and a large number of other items have been investigated by the researchers.

Twin Coach Machine Folds Metal Into Corrugations

Metal can be folded into corrugated shapes with a unique machine developed by Twin Coach Co., Buffalo, N.Y.

In contrast to the usual method of drawing such configurations, the device makes possible simultaneous perforating, off-setting, slotting or lancing. Thus an infinite variety of patterns is possible.

The key element in the process is a cam-controlled action, which moves the forming dies in both horizontal and vertical planes. Die costs range from $800 for a simple design to $3500 for complex ones. But each die gives about 1000 hours of use.

At present, folded metal is available in gauges from 0.002 to 0.030 in. at a tolerance of 0.001 in.

RESEARCH AND DEVELOPMENT AT LOCKHEED

...is setting the pace in space for years ahead

Lockheed Missiles and Space Division's progress transcends even that of an era marked by phenomenal scientific growth. To an important degree, the Division's research and development activities are considered to be the basis of its success.

As systems manager for the Navy POLARIS Missile and the Air Force AGENA Satellite in the DISCOVERER, MIDAS and SAMOS programs, the Division is engaged in extensive research in many diverse engineering and scientific fields. Some highlights of current research and development activities include: Operations research and preliminary design; nuclear and space physics; physical electronics; chemistry; materials; mathematics; engineering mechanics; electronic communications and instrumentation; and computer research and development.

Research is a concept which holds many different meanings to those concerned with science and technology. At Lockheed, a distinction is made between the *nature* of the work and its *objectives*. Consequently, such terms as basic research, applied research, systems or operations analysis, engineering and development are used. A given individual might find that his personal inclination often leads him quite naturally from one type of research to another. Recognition of this desire is reflected in the scope of work conducted in the Research Branch at Lockheed Missiles and Space Division. Principal research activities are: Pure and applied research; advanced design; engineering analysis; electronic prototype development; and machine computation.

Organization is determined by the *technical field* rather than by the *type of research*. For example, a structural dynamicist, as a member of the Structures Department, may, on one occasion, work on future space vehicle configurations, at another time be associated with current projects such as the POLARIS or Satellite programs, or he may be engaged in basic research at the research laboratory. In each case, the individual has the opportunity to maintain as much or as little contact as he wishes with others in his field of interest.

Important staff positions at Lockheed's Research and Development Branch in Palo Alto are available. Those scientists and engineers with experience related to the above areas are invited to write to: Research and Development Staff, Dept. I-29A, 962 West El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance is required.

Lockheed / **MISSILES AND SPACE DIVISION**

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA • HAWAII

SEPTEMBER, 1960

Missiles and Rockets

ASTROLOG

A status report on U.S. missiles and rockets and all space vehicles presently in orbit

★ *Indicates change since July 4 edition*

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
SPACE VEHICLES			
ADVENT (ARPA-Air Force)	GE-Bendix prime for polar-orbiting phase	New overall name for advanced communications satellites STEER, TACKLE and 24-hour instantaneous repeater called DECREE	R&D
★AEROS (NASA)	No contract announced	24-hour weather satellite to be boosted by CENTAUR or SATURN	Planning. First flights would be i 1964 or 1965
★AGENA (Air Force)	Lockheed, prime; Bell, propulsion	1700-pound satellite after burnout; AGENA B stop-start engine will have about double fuel capacity of AGENA A	Used in DISCOVERER program larger AGENA B also to be use with ATLAS and THOR. NASA als will use to take place of cancelle VEGA
★APOLLO (NASA)	No contract announced	Three-man spacecraft capable of orbiting moon or becoming space station; probably winged for lunar flights; boosted by SATURN	Competition on for 6-month stud contract to be awarded Nov. 14 R&D prime to be chosen in FY '6
ATLAS-ABLE (NASA)	STL, prime; GE/Burroughs, Arma, guidance; Rocketdyne, Aerojet-General, ABL, propulsion	Orbit 200-lb. vehicle around moon or send into deep space	Two lunar orbit attempts beginnin this summer
CENTAUR (NASA)	Convair, prime; Pratt & Whitney/-JPL, propulsion	Pair of LOX-liquid hydrogen engines, 30,000 lbs. total thrust, atop ATLAS booster, capable of orbiting 8000 lbs. or accelerating almost 3000 lbs. to escape velocity	First test flight in 1961; first engin delivered
★COURIER (ARPA-Army)	Army Signal Corps, prime	Delayed repeater communications satellite	COURIER IA launching failed i August because of booster blow-up Next shot expected in October
★DISCOVERER (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA launchings of early stabilized satellites; main purpose is to test techniques for SAMOS	14 launchings; capsule recovere from orbit on No. 13 & 14. No. 1 to carry small primate. Total 35 shot planned
DYNA-SOAR I (Air Force)	Boeing, space craft and systems integrator; Martin, propulsion	Boost-glide orbital space craft; first space bomber; TITAN I booster; TITAN II probably to be used later	R&D; first glider flights from Ed wards AFB by 1962; intensive ma terial studies underway
★ECHO (NASA)	Langley Research Center, prime	Puts 100 ft. inflatable sphere in 1000 mile orbit; passive communication satellite	Second launching attempt successf Aug. 12
★FIREFLY (NASA)	No contract announced	Geodetic survey satellite	No funding
JUNO II (NASA)	ABMA/Chrysler, prime; Ford Instrument, guid.; Rocketdyne/JPL, prop.	Early deep space booster; small payload	Five more shots planned
★MARINER (NASA)	JPL, prime	600-1200 lb. unmanned spacecraft for early interplanetary missions; boosted by ATLAS-AGENA B	Seven shots planned beginning ne year
★MERCURY (NASA)	NASA, prime; McDonnell, capsule	First manned satellite	Program slipping about one yea First manned capsule launching b REDSTONE down Altantic Range st scheduled for Dec. but probably w slip to 1961. First manned orbit sh still scheduled for 1961
MIDAS (Air Force)	Lockheed, prime	Early-warning satellite; detect ICBM launchings by infrared before birds leave pad; R&D models weigh 2 tons; operational system to have 12-15 satellites	R&D; second launching May 24 pa tial success
★NIMBUS (NASA)	Contract to be let shortly	Follow on to TIROS weather satellite	First launching scheduled for ear 1962

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
OVA (NASA)	No prime announced; Rocketdyne, propulsion	Clustered 6-9 million lb. booster plus upper stages	Early R&D on 1.5 million lb. F-1 engines
OAO (NASA)	No contract announced	3500-lb. orbiting astronomical satellite observatory equipped with telescope; boosted by ATLAS-AGENA B	Contract to be awarded soon; 11 firms or teams competing
OGO (NASA)	No contract announced	1000-lb. satellites with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; ATLAS-AGENA B booster	Procurement planned in early 1961
RION (ARPA-Air Force)	General Atomic	Space station launched by series of atomic explosions	Advanced engineering studies under way; tests may be attempted; program shifted to Air Force alone
PROJECT 3059	Aerojet-General, Grand Central, propulsion	Solid motor in 1 million to 2 million lb. thrust class	Research determining feasibility; NASA contracting for complementary studies with United Technology Corp.
PROSPECTOR (NASA)	No contract announced	Soft-landed, remote control, unmanned moon exploring spacecraft. SATURN booster	Planning. First flight planned by 1965
RANGER (NASA)	JPL, prime; Aeronutronic, capsule; Hercules, retrorocket	300-lb. rough landed instrumented capsule on moon; ATLAS-AGENA B booster	R&D; first flight planned 1961 or 1962
REBOUND (NASA)	No contract announced	System of 12 or more passive communications satellites launched several at a time	Study
SAMOS (Air Force)	Lockheed, prime	Reconnaissance satellite; formerly SENTRY	R&D; stabilization already achieved in DISCOVERER series; first test launching scheduled this year; scheduled to be operational late 1962, early 1963 under new, bigger program
ATURN (NASA)	NASA Marshall Center, prime and booster; Douglas and Convair, upper stages; Rocketdyne, booster and mid-stage engines; Pratt & Whitney, top-stage engines	Series of multistage vehicles based on 1.5-million-lb. clustered booster and upper stages using combinations of LOX-liquid hydrogen engines. Earliest model will orbit 20,000-lb. payload	Static firings of clustered booster in progress successfully since April; first flight test spring of 1961; flight with live upper stages scheduled 1963
★SCOUT (NASA-Air Force)	Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Allegany/Thiokol, propulsion	Solid four-stage satellite launcher; 200 lb. payload in orbit	Air Force and probably Navy also to use for research; first test in April and July partially successful; AF version called HETS
★SURVEYOR (NASA)	No contract announced; STL, McDonnell, North American, Hughes competing	Soft-landed 100-300 lb. instrumented spacecraft on moon; ATLAS-CENTAUR booster	Competing studies to be completed in November; R&D contract to be awarded 1961; first moon flights '63-'64
★THOR-ABLE-STAR (Air Force-NASA)	STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion	Three-stage vehicle with orbital capability of 200 lbs. New ABLE-STAR upper stage has restart engine, boosts heavier payload	THOR-ABLE phased out. THOR-ABLE-STAR operational in TRANSIT and COURIER
THOR-AGENA (Air Force)	Lockheed, prime; Bell, propulsion	Two-stage vehicle capable of orbiting more than 300 lbs. AGENA-B restartable upper stage boosts payload capacity to 1250 lbs.	Operational in DISCOVERER program. AGENA-B first used May 24 to launch MIDAS II. NASA to use extensively beginning late '61
★THOR-DELTA (NASA)	STL, prime; IT&T, guidance; Rocketdyne / Aerojet-General / Allegany, prop.	Improved THOR-ABLE with 480-lb. payload capability	To be used in ECHO and TIROS programs. Used successfully in ECHO I shot
★TIROS (NASA-AF-Army-Navy-Wea. Bu.)	RCA-Army Signal Corps, prime	Meteorological satellite; TV pictures of cloud cover	R&D; first launching in April a success; two more scheduled; one late this year
★TRANSIT (ARPA-Navy)	Johns Hopkins Laboratory, prime	Navigational satellite; R&D model weighs more than 250 lbs.; operational model about 50 lbs.	TRANSIT IB R&D satellite put in orbit April 13; IIA plus piggyback satellite successfully in orbit June 22, four satellite TRANSIT systems scheduled operational 1962; next R&D launching late fall
TRIBE (ARPA)		Family of space launching vehicles	Planning
★VOYAGER (NASA)	No contract announced	Unmanned spacecraft to orbit Mars or Venus; eject capsule for re-entry; SATURN booster	Study; first flight planned by 1965
YO YO (Navy)	No contract announced	Tactical sea-launched one-pass reconnaissance satelloid	R&D

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
X-15 (NASA-AF-Navy)	North American, prime; Thiokol, propulsion	Rocket plane; 3600 mph; flight at edge of space; on AF model each XLR-11 rocket engines develop 16,000 lbs. of thrust; later XLR-99 engines to develop 50,000 lbs. Three planes delivered	Powered flights in progress; plane #1 has hit Mach 3 and more than 80,000 ft. with XLR-11 engine; plane #2 out of operation for installation of more powerful XLR-99 engine for fall flight; plane #3 heavily damaged by fire June 8 in test prior to flight with XLR-99

MISSILES & ROCKETS

ALFA (Navy)	Avco, prime	ASW surface-to-underwater; 500 lb. solid; conventional; formerly called ABLE	Deployed on destroyer escorts
ASROC (Navy)	Minneapolis-Honeywell, prime; Sangamo Electric, Sonar; Torpedo, GE; depth charge, M-H.	Surface-to-underwater; solid rocket torpedo or depth charge; nuclear or conventional, range about 8 miles	R&D; operational on Destroyers Norfolk & Peary; plans call for deploying on 150 destroyers and cruisers
ASTOR (Navy)	Westinghouse, prime	ASW underwater to underwater; rocket torpedo; nuclear	R&D
★ATLAS (Air Force)	Convair, prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE, re-entry vehicle	ICBM; more than 5500-to-7500 mile range; liquid; nuclear; Atlas "E" series has inertial guidance; earlier Atlas "D" has radio inertial	60 military launchings: 39 successes, 8 partial, 13 failures; 6 scientific launchings: 4 successes, 1 partial, 1 failure. 11 scheduled sites for 13 squadrons named; partial squadrons operational at Vandenberg A
★ARM (Air Force)	No contract announced	Anti-radar missile	Studies; plan for separate missile shelved at least temporarily
BOMARC-A (Air Force)	Boeing, prime; Westinghouse, guidance; Marquardt/Aerojet, propulsion	Ramjet surface-to-air interceptor; liquid booster; 200 m. range; Mach 2.7; nuclear	First squadron operational at McGuire AFB, N.J.
BOMARC-B (Air Force)	Boeing, prime; Westinghouse, guidance; Thiokol, propulsion	Ramjet, surface-to-air; solid booster; Mach 2.7; more than 500 m. range; nuclear	Ten launchings: 2 successes, 8 failures; first successful flight April 14. Production program sharply cut back by Air Force
BULLPUP (Navy-Air Force)	Martin, prime; Martin, guidance; Thiokol (Reaction motors), propulsion	Air-to-surface; 4-8 mile range; conventional 250-lb. bomb; new model has pre-packaged liquid; nuclear-tipped model under development	Deployed with Atlantic and Pacific Fleets; bigger model under R&D; Air Force buying modified version; Marines launching BULLPUP from helicopters
COBRA (Navy)	No contract announced	Anti-ship radar missile	Early R&D
COBRA (Marines)	Boelkow Entwicklungen, West Germany, prime; Daystrom, U.S. distributor	24.6-pound anti-tank missile; 1 mile range; 191 mph speed; solid propellant	Marines planning to purchase; Army considering them; already operational with West German troops
CORPORAL (Army)	Firestone, prime; Gilfillan, guidance; Ryan, propulsion	Surface-to-surface; 75-mile range; liquid; nuclear	Deployed with U.S. & NATO troops in Europe
CORVUS (Navy)	Temco, prime; W. L. Maxson guidance; Reaction Motors, propulsion	Air-to-surface; pre-packaged liquid; radar homing; about 100-miles range	First successful test July 18, 1959
CLAYMORE (Army)	No contract announced	Anti-personnel missile	R&D
CROW (Navy)	No contract announced	Air-to-air missile	R&D; has been flight tested
DAVY CROCKETT (Army)	In-house project at Rock Island, Ill., arsenal	Surface-to-surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers of different size for various ranges; vehicle mounted or carried by two men	R&D; operational in FY '61; first NATO deliveries also FY '61
★EAGLE (Navy)	Bendix, prime; Bendix, guidance; Aerojet propulsion; Grumman, airframe	Air-to-air; 100-mile range; nuclear; for launching from relatively-slow Douglas Missileers now under development; Eagle is 15 ft. long; wt., about 2000 lbs., Mach 4; solid	R&D; Missileer production run reported to be 120 in next few years
★FALCON (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion	Air-to-air; 5-mile range; Mach 2; solid; conventional; GAR-11 has nuclear warhead	GAR-1 through GAR-4 operational; GAR-9 & 11 R&D
GENIE (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air; unguided; 1.5-mile range; nuclear	Operational
GIMLET (Navy)	No contract announced	Air-to-surface; unguided; considered highly accurate	R&D
HAWK (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 20-mile range; solid; conventional; designed to hit low-flying planes	Operational; units training for early deployment to Europe and Far East; advanced Hawk under development; Jan. 29 successfully intercepted Honest John, first known intercept of one tactical missile by another

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
ONEST JOHN (Army)	Douglas, prime; Hercules, propulsion	Surface-to-surface; unguided; 16.5-mile range; nuclear	Operational; deployed in Europe
OUND DOG (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air-breathing air-to-surface; 500-mile range; Mach 1.7; turbojet; nuclear	Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400; training fully underway
UPITER (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion; Goodyear, re-entry vehicle	IRBM; liquid; nuclear	To be deployed with Italian troops in Italy and may be used as AICBM target drone; 29 military launchings: 22 successes; 5 partials; 2 failures. One 15-bird squadron to be deployed in Turkey. Last R&D test shot launched Feb. 4
LACROSSE (Army)	Martin, prime; Federal Telecommunications Laboratories, guidance; Thiokol, propulsion	Surface-to-surface; highly mobile; 20-mile range; solid; nuclear	Operational; 4 units being trained; 3 more planned for 1960; being deployed in Europe and Far East; advanced LACROSSE R&D program dropped at least temporarily
TTLE JOHN (Army)	Emerson Electric, prime; ABL, propulsion	Surface-to-surface; unguided; 10-mile range; solid; nuclear	Operational this year; units training with it
OBBER (Army)	No contract announced	Surface-to-surface; cargo carrier; 10-15 mile range; also can drop napalm; LOBBER with warhead called BALLISTA	Studies
LULU (Navy)	General Mills/Naval Ordnance Lab, prime	Small nuclear depth charge air-dropped or launched by ASROC	Operational
MACE (Air Force)	Martin, prime; AC Spark Plug, guidance; Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid; nuclear; B model has 1000-m. range	Being deployed with U.S. troops in West Germany; now all mobile but hard-base version in R&D; first launched from prototype hard site in July
ATADOR (Air Force)	Martin, prime; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 650-mile range	Being turned over to West Germans; also deployed in Far East
MAULER (Army)	Convair, prime	Surface-to-air; IR guidance; highly mobile antiaircraft and antimissile missile for field use; to be on tracked vehicle; 12 missiles in each launcher	R&D; NATO may buy
MINUTEMAN (Air Force)	Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules, third stage; Avco, re-entry vehicle; AMF-ACF rail launcher	2nd generation ICBM; solid; fixed or mobile aboard railroad trains; nuclear; 3 stages	R&D; scheduled to be operational mid-1962 at Malmstrom AFB; launching of eight tethered birds from silos successfully completed in May; first full R&D launching from Cape in Dec.; tactical rail system tests completed
-55 (Army)	Norris Thermodor, prime	Four-inch diameter, small, short-range poison gas rocket; to be fired from 45-tube launchers	Operational
ISSILE A (Army)	ARGMA to act as prime; six R&D contracts for components scheduled to be let soon	Surface-to-surface; 65-70 mile range; solid	Design studies
IKE-AJAX (Army)	Western Electric, prime; Western Electric, guidance; Hercules Powder, propulsion	Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional	Deployed in U.S., Europe & Far East; about 170 batteries in U.S.
NIKE-HERCULES (Army)	Western Electric, prime; Western Electric, guidance; Hercules & Thiokol, propulsion	Surface-to-air; 80-mile range; Mach 3+; nuclear; effective against tactical missiles as well as aircraft; mobile or fixed installation	Rapidly replacing NIKE-AJAX; more than 80 batteries deployed in U.S.
NIKE-ZEUS (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol and Grand Central, propulsion	Anti-missile; 3-stage; 200-mile range; solid; nuclear	R&D test launchings at White Sands. 9 R&D launchings: 6 successful, 2 partial, 1 failure. Test shots in the Pacific planned in mid-1961. Earlier shots from Pt. Mugu, Calif., into PMR. Administration has refused to okay Army recommendation to begin major production
ERSHING (Army)	Martin, prime; Bendix, guidance; Thiokol, propulsion	Surface-to-surface; two-stage solid; approx. 500-mile range; nuclear; transported on tracked FMC XM474 tracked vehicle	R&D; to replace REDSTONE; 6 R&D launchings (live first stage; dummy second): 6 successes. Expected operational late 1962
OLARIS (Navy)	Lockheed, prime; GE, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle	Underwater and surface-to-surface; solid; 1200-mile range can hit more than 90% all targets in Russia; nuclear	67 launchings of test vehicles: 46 successes; 18 partial; 3 failures; launched from surface ship Aug. 27, 1959; expected on station late in 1960; 1100-mile plus range vehicles under test at Cape Canaveral; first sub launchings this summer; 14 subs built, building or authorized; 5 long-lead items authorized by DOD, 2 more by Congress

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
RAVEN (Navy)	No contract announced	Air-to-surface; about 500-mile range	Study
REDEYE (Army)	Convair, prime; Atlantic Research, propulsion	Surface-to-air; 4-foot, 20-lb. bazooka-type; IR guidance; solid; conventional; container-launcher disposable	R&D; Marines also will use; NATO may buy
REDSTONE (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; nuclear	Deployed with U.S. troops in Europe to be replaced by Pershing
REGULUS II (Navy)	Chance Vought, prime; Stavid, guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet & solid; 500-mile range; nuclear	Deployed aboard U.S. submarines used as target drone
SERGEANT (Army)	JPL/Sperry, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; more than 75-mile range; nuclear	Production. To replace CORPORA this year
SHILLELAGH (Army)	Aeronutronic, prime	Surface-to-surface; lightweight; can be vehicle-mounted	Early R&D
SIDEWINDER (Navy)	GE-Philco, prime; Avion, guidance; Naval Powder Plant, propulsion	Air-to-air; IR guidance; 6-7-mile range; conventional; new I-C models to have switchable IR and radar-guided warheads	Deployed with Navy and Air Force all-weather type under developmen
SKY BOLT (Air Force)	Douglas, prime; Nortronics, guidance; Aerojet, propulsion; GE, re-entry vehicle	Air-launched ballistic missile; more than 1000-mile range; solid; nuclear	R&D; to be purchased by British; operational 1964-65; both U.S. an British planes to test-launch from Eglin AFB, Fla.
SLAM (Air Force)	No contract announced	Surface-to-surface; low-altitude; supersonic; nuclear-powered ramjet; nuclear	Study-R&D
SNARK (Air Force)	Norair, prime; Northrop, guidance; Aerojet-General, propulsion	Surface-to-surface; 5500-mile range; solid and turbojet; Mach .9; nuclear	Deployed at Presque Isle, Maine
SPARROW III (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol, propulsion	Air-to-air; 5-8 mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional	Operational with carrier aircraft earlier SPARROW I obsolete; ne contract aimed at extending rang and altitude
SUBROC (Navy)	Goodyear, prime; Kearfott, guidance; Thiokol, propulsion	Underwater or surface-to-underwater; 25-30 mile range; solid; nuclear	Estimated operational date: 196 To be installed first on Threshe nuclear-powered attack submarine
SS-10 (Army)	Nord Aviation, prime	Surface-to-surface; primarily anti-tank; 1600-yards range; 33 lbs. solid; wire guided; conventional	Operational with U.S., French an other NATO and Western unit battle-tested in North Africa
SS-11 (Army)	Nord Aviation, prime	Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs.; wire guided; conventional	Operational. Under evaluation b Army
TALOS (Navy)	Bendix, prime; Farnsworth/Sperry, guidance; Bendix/McDonnell, propulsion	Surface-to-surface; 65-mile range; solid & ramjet; Mach 2.5; nuclear	Operational aboard cruiser Galve ton
TARTAR (Navy)	Convair, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional	Many test firings in Pacific; e pected deployment 1960 as prima armament of guided missile d stroyers; production
★TERNE (Navy)	Kongsberg Vapenfabrikk, prime; Arma, systems integration	Surface-to-underwater ASW missile; 264 lbs.; 102 in. long; 105-lb. warhead	The Navy is buying the Norwegi missiles to equip two destroyer e corts
TERRIER (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	Surface-to-air; 10-mile range; Mach 2.5; 27 feet long; solid; conventional	Operational with fleet
TERRIER-ADVANCED (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	About 100% performance improvement over TERRIER	Operational Advanced TERRIERS be deployed about mid-1960
★THOR (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE, re-entry vehicle	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear	Operational; 4 bases set up in En land. 63 military launchings: 42 s cesses; 11 partial; 10 failures; 35 s entific launchings: 29 successful, partial; 4 failures; R&D and " rod" advanced tests complet Feb. 29
★TITAN (Air Force)	Martin, prime; Bell/Western Electric, Remington Rand, TITAN I guidance; AC Spark Plug, TITAN II guidance; Aerojet-General, propulsion; Avco, re-entry vehicle	Surface-to-surface ICBM; 5500-mile range; liquid; 90 feet long; nuclear; TITAN I burns LOX-Kerosene; TITAN II has storable propellants, inertial guidance, bigger payload, greater range	21 launchings test vehicles: 14 s cesses; 2 partial; 5 failures. 8 si for 12 squadrons named; 14 squ rons planned; TITAN I operatio fall 1961; first Vandenberg laun ings scheduled this Oct.; TITAN scheduled to be operational e 1963
TYPHON (Navy)	Westinghouse, prime; Bendix propulsion	Medium and long range seagoing anti-missile missiles; formerly called SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional; supersonic	Early R&D; may be used on hydro destroyers

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
VAGTAIL (Air Force)	Minneapolis-Honeywill, prime	Air-to-ground; low-level; solid; designed to climb over hills and trees	R&D
VILLOW (Army)	Chrysler, prime	Highly-classified missile	R&D
UNI (Navy)	Naval Ordnance Test Station, prime	Air-to-air, air-to-surface; solid; unguided rocket; 5-mile range; conventional	Operational

SATELLITES

SATELLITE	COUNTRY	STATUS
★EXPLORER I (30.8 lbs.)	U.S.	Launched 1/31/58, est. life 3-5 years. Orbits earth, perigee: 213.9 m., apogee: 1192.9 m., period: 107.8 min. (Discovered Van Allen Belt); not transmitting.
★VANGUARD I (3.25 lbs.)	U.S.	Launched 3/17/58, est. life 200-1000 years. Orbits earth, perigee: 406 m., apogee: 2450.7 mi.; period: 133.9; still transmitting.
★LUNIK I "MECHTA" (3245 lbs.)	RUSSIA	Launched 1/2/59. Believed to be in orbit around sun on 15 mo. cycle; not transmitting.
★VANGUARD II (20.7 lbs.)	U.S.	Launched 2/17/59, est. life 10 years +. Orbits earth but is "wobbling," perigee: 346.4 m., apogee: 2047.7, period: 125.4 min., inclination to equator: 32.88°; not transmitting.
IONEER IV (13.40 lbs.)	U.S.	Launched 3/3/59. Orbits sun, and achieved primary mission, an Earth-Moon trajectory; not transmitting.
★EXPLORER VI "PADDLE-WHEEL" (142 lbs.)	U.S.	Launched 8/7/59, est. life: to Aug. 1961. Orbits earth, former perigee: 156 m., former apogee: 26,357 m., former period: 12½ hours, present orbit unknown; speed: at perigee 23,031, at apogee 3126 mph., inclination to equator: 46.9°; not transmitting.
★VANGUARD III (about 100 lbs.)	U.S.	Launched 9/18/59, est. life 30-40 years. Orbits earth, perigee: 322.6 m., apogee: 2320 m.; period: 129.9; not transmitting.
UNIK III (about 614 lbs.)	RUSSIA	Launched 10/4/59, est. long life, orbits earth-moon; took first picture far side of moon; est. perigee: 30,000 m., apogee: 291,000 m.
★EXPLORER VII (91.5 lbs.)	U.S.	Launched 10/13/59, est. life 20 years, orbits earth, perigee: 343.7, apogee: 673; period: 101.2; transmitter to cut off in October.
★DISCOVERER V CAPSULE (less than 300 lbs.)	U.S.	Launched 8/13/59. Satellite burned up in atmosphere Sept. 28. Capsule also thought to have been destroyed, but it was later rediscovered and first thought to be an unidentified Soviet satellite. Est. life several months; period: 98.9; perigee: 119.6, apogee: 756.4.
★PIONEER V (94.8 lbs.)	U.S.	Launched 3/11/60, est. life: forever; orbits sun, interplanetary radio communication satellite, passed 20 million miles June 20; not transmitting.
★TIROS I (270 lbs.)	U.S.	Launched 4/1/60, est. useful life: 3 mos., perigee: 428.9 m.; apogee: 468.1; period: 99.2. Picture-taking weather satellite; still transmitting.
★TRANSIT IB (265 lbs.)	U.S.	Launched 4/13/60, est. life: 16 mos. minimum; perigee: 237.7; apogee: 442.9; period: 95.6. First R&D navigation satellite. Not transmitting.
★SPUTNIK IV (10,008 lbs.)	RUSSIA	Launched 5/15/60; est. life: relatively brief; original perigee: 188; apogee: 229; changed to 191/429 on May 19. Last reported—Period: 94; perigee: 174.7; apogee: 406.2. Test of support systems, cabin, for manned space flight; attempt to return from orbit failed because of poor orientation of retrorocket.
★MIDAS II (5000 lbs.)	U.S.	Launched 5/24/60; est. life: 40 months; perigee: 300.1; apogee: 318.4; period: 94.4; Telemetry for IR scanning failed two days after launch; still transmitting.
★TRANSIT II-A (223 lbs.)	U.S.	Launched 6/22/60; est. life: 50 years; period: 101.7; perigee: 389.2; apogee: 650.5; still transmitting.
★NRLI "GREB" (40 lbs.)	U.S.	Launched 6/22/60 with TRANSIT II-A; period: 101.7; perigee: 657.8; apogee: 657.8. Solar radiation measuring satellite; still transmitting.
★DISCOVERER XIII (1700 lbs.)	U.S.	Launched 8/10/60; period: 94; perigee: 156.6; apogee: 425.5; 300-lb. capsule successfully ejected from orbit and recovered from Pacific 8/11—the first satellite to be recovered from orbit.
★ECHO I (132 lbs.)	U.S.	Launched 8/12/60; est. life: one year; period: 118.2; perigee: 957; apogee: 1038.4; first successful orbiting of a passive communications satellite.
★DISCOVERER XIV (1700 lbs.)	U.S.	Launched 8/18/60; period: 94.5; perigee: 116; apogee: 502; 300 lb. capsule ejected from orbit and recovered for the first time in the air by a C-119 aircraft over Pacific.
★SPUTNIK V (10,120 lbs.)	RUSSIA	Launched 8/19/60; period: 90.72; perigee: 190; apogee: 211. Capsule of undisclosed configuration and weight carrying two dogs and other living organisms successfully ejected from orbit and recovered in meadow—the first successful return of an animal from orbit.

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Army Gets Liquid Test Facilities in Navy Turnover

THE ARMY has expanded its liquid-propellant test facilities through the turnover to Picatinny Arsenal, the Army Ordnance ammunition development center, of the adjacent Naval Air Rocket Test Station at Lake Denmark, N.J.

The Ordnance Corps thus acquired 760 acres of land and 215 buildings, including 68 permanent warehouses, valued at approximately $12 million.

Picatinny Arsenal is located near Dover, N.J., about 30 miles northwest of New York City.

A new Liquid Rocket Propellants Laboratory has been activated in the Arsenal's Ammunition Group; it absorbed 81 civilians formerly employed by the Navy. Irving Forsten, former technical director of the NARTS Rocket Propulsion Laboratory, has been named Chief, LRPL, by Picatinny.

Dr. John D. Clark, chief chemist at NARTS since 1949, will be Chief, Propellant Section, while John J. Caravan, who had been at NARTS since 1952, becomes Chief, Rocket Engine Section.

• **Variety of test stands**—Among the testing facilities which now will be utilized in the Army's research and development program are:

–A liquid-propellant rocket engine test stand—capacity to 350,000 lbs. thrust. Instrumentation can measure 96 channels.

–A test stand equipped to test liquid-propellant rockets having their own tankage or high-thrust solid-propellant rockets—capacity 100,000 lbs. thrust. Equipped with remote control, closed-circuit TV.

–Two dual-mount test bays capable of testing liquid-propellant rocket engines up to 10,000 lbs. thrust, also equipped with closed-circuit TV.

–A test stand testing solid-propellant motors and JATO's up to 40,000 lbs. thrust, equipped with closed-circuit TV.

–A test stand capable of testing liquid- and solid-propellant engines up to 30,000 lbs. thrust.

–Eight stands accommodating liquid-propellant rocket engines up to 10,000 lbs. thrust.

–Two stands, one a double-bay stand and the other a variable attitude stand, for liquid-propellant rocket engine testing. The former can withstand 15,000 lbs. thrust, while the variable attitude stand is rated to 20,000 lb thrust.

–Three double-bay test stands whic can test liquid-propellant rocket e gines up to 15,000 lbs. thrust.

Among the other facilities t Arsenal acquired in the turnover a a components workshop for cold tes ing and flow testing of components, instrumentation workshop, a temper ture conditioning pad, a JATO exhau temperature and blast pressure facilit a hazardous propellant-handling buil ing, a centrifuge, a shock tester, a dr test facility, an environmental te building, a physical chemistry labor tory, an analytical chemistry laborato and a shops branch.

The Reaction Motors Divisio Thiokol Chemical Corporation, leas 10 test stands and four double-b stands in three areas. Storage facilit capable of accommodating 13,000 g lons of ammonia and nitrogen gasific tion equipment are included.

Other staff members for the n Liquid Rocket Propellants Laborato include William F. Lehman, specia in qualification test and evaluation p grams; Frederick R. Hickerson, auth ity on advanced liquid rocket eng concepts and Edward A. Jenkins, el tronics expert and technical consulta

Sperry Rand Enters Range Instrumentation Field

Eyeing what it foresees as a billi dollar market, Sperry Rand has inc porated a Missile Range Instrumen tion group to "design, develop, produce compatible missile range tems." Divisions participating direc in the effort include Ford Instrume Remington Rand Univac, Sperry Gy scope, and Vickers, Inc.

The decision to enter this fi according to a company spokesm was based on a lengthy study wh revealed a need—and a market pot tial—for complete, integrated range strumentation. They concluded t range instrumentation has not k pace with missile development and an urgent need exists for compat and integrated systems.

The announcement said that Spe Rand is perhaps the only corporat having the built-in resources to vide such extensive coordinated ins mentation.

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Monkey Will 'Study' Weightlessness

Discoverer series' first orbit of primate—due next month—will carry elaborate instrumentation and highly trained animal

by Heather David

Much long awaited physiological data required for America's manned spaceflight program may be obtained by the Air Force next month when an attempt probably will be made to orbit a primate in a *Discoverer* capsule.

Now tentatively ticketed for *Discoverer XVI,* the first animal to be launched by the U.S. in an earth orbit will be a tiny 5-8-lb. American rhesus monkey—an animal which closely resembles man in physical arrangement and development of certain parts of his brain. The monkey previously had been expected to go aboard *Discoverer XV.*

Major goal in the test, said Brig. Gen. Don D. Flickinger, Assistant for Bioastronautics, is to determine the ability of higher mammals to function during extended periods of weightlessness. Humans have experienced weightlessness as long as 90 seconds; the *Discoverer* trip will extend this knowledge to 17 or 18 hours.

More intelligent than dogs, the monkey can perform certain decision-making or reasoning tasks. This fact may forecast some of the effects of space travel on man's mental capabilities.

At various phases of the trip, psychomotor tests of the see-light, pull-lever variety will be given to the tiny subject. More complex tests and more detailed monitoring of brain activity will be programed for subsequent flights.

The *Discoverer* capsule will carry a lighter load of telemetry instrumentation than did the recent Russian flying menagerie, mostly because of sheer weight and power limitations. However, Air Force medical experts say that not all the Soviet devices were necessary to get an adequate description of the effects of the flight on the animals.

General Electric's Missile and Space Vehicle Department designed and manufactured the *Discoverer* capsule under a Ballistics Missiles Division contract. It will include sensors to measure respiration, pulse, blood pressure, EKG (electrocardiogram) and body temperature. Probable additional monitors would include a phonocardiogram (heart sounds) and an eye motion detector (to indicate motion sickness and other disturbances of equilibrium).

A 'TEEN-AGE' (16-18 months) rhesus much like this one is now getting flight instructions for Discoverer trip.

- **Banana pie in the sky**—Food will be administered to the astrosimian in the form of small dehydrated pellets. Not at all as unappetizing as they may sound, these are the same pellets used during training to reward him for completing psychomotor tasks.

Enough food, water and oxygen will be provided to sustain a two-hour countdown, approximately 27-hours mission time and several hours safety period.

Capsule environment will be maintained at a slightly rarified atmosphere of 8-10,000 ft., according to the Air Force. Temperature, under a monkey-comfort-index, will be kept at about 80°F, with humidity at less than 50%. Temperature variant is less than ±5°, pressure less than 1 lb. psi.

Although radiation-measuring devices will be carried aboard, no serious hazard is anticipated from radiation. The Air Force will aim for a near-circular orbit at about 160 m., well below the 600-mile limit medical experts set for dangerous radiation. Greatest apogee for a recent *Discoverer* orbit has been 502 miles, set by *XIV.*

Normal launch, acceleration and re-entry should present no problems in the way of g forces, which will be slightly less than with *Atlas* vehicles. The animal will encounter forces of 7 g's during acceleration and a short duration of 12-15 g's during re-entry. Rate of descent before impact will be about 20-25 ft. per second—less than 1 g.

Throughout the trip the monkey will be esconced on a contour-fitting couch, much like those used in previous short flights. A lightweight nylon harness will permit him limited movement.

- **It's all in the mind**—Preconditioning plays an all-important part in the scientific validity of these tests. An animal's physiological reactions will depend to a great extent on its "nervous system." For instance, sheer fright during weightlessness would produce an abnormal electrocardiogram, but the weightless condition itself would not be responsible for unusual heart activity.

The five potential *Discoverer* passengers have undergone extensive training at the Balconnes Laboratory of the University of Texas, Austin, under a School of Aviation Medicine contract. Isolation, g-forces, high temperatures are all part of the course.

The monkey provides an excellent experiment subject not only because of his manlike qualities, but because long-term effects will appear five times as fast because of the shorter life span.

If unexpected radiation exposures should occur, high dosages would of course be immediately obvious. Breakdown of white blood cell mechanism would occur in a day or so; cancers, leukemia, etc., resulting from lower dosages would appear within months.

- **Tight scheduling**—Although it is very probable that the monkey shot will come in *Discoverer XVI,* the wedding of the biomedical package to the launch vehicle might cause a hitch, a high Air Force official told M/R. If some difficulty occurs in the lengthy process, a non-live shot might be substituted to keep on schedule.

The regular Air Force schedule (excluding the monkey shot moved up from next year) calls for the first *Thor-Agena B* on *Discoverer XVI.* The greater capability of the *B* vehicle over the *Thor-Agena A* will make it very possible that if all goes well with the monkey, a 30- or 40-lb. chimp might not be far back in line.

All-attitude Liquid Gage Developed

System made by Liquidometer Corp. can measure oxygen supply of astronaut or liquefied metals in propulsion

Los Angeles—Space flight presents unusual problems in accurate gaging of liquids, which might be forced to any part of a tank by varying g-forces or which might float in a tank in globules under zero-gravity conditions.

An all-attitude liquid-quantity gage to meet these problems has been developed by the Liquidometer Corp. The company says it is both simple and extremely accurate.

A typical application of the gage is in the measurement of an astronaut's breathing oxygen. Another application is the gaging of liquefied metals in advanced propulsion systems.

Space Simulation

STRESSES WHICH DYNA-SOAR flight will impose are being calculated by the Space Medicine section at Boeing Airplane Co. Depressurization, extreme heat and high level noise are simulated simultaneously in this sealed chamber.

The heart of the system is a capacitance liquid-measuring probe. This consists of a matrix structure of wires or tubes in cubical form, with a second, independent, structure enclosed by the first. The two electrically independent circuits form the two active terminals of a three-terminal capacitor. The vehicle shell forms the third terminal.

The structure is built to fill the entire volume of a tank and measures the liquid on a digital basis. Whenever one of the capacitor cubes is filled with liquid, a change in capacitance occurs. This is measured in a bridge circuit by an instrument-type servo system.

- **No up, no down**—The design has no top or bottom reference. It can sense liquid quantity within the tank in any attitude or while undergoing violent agitation.

Regardless of the shape or location of the liquid and foam throughout the tank, the capacitance added by the liquid will be essentially the same and thereby produce essentially the same indicator reading.

In addition to operating an indicator gage, the output of the system can be telemetered, used for control purposes or fed into a computer for overall performance information.

Due to the large gaps between wires, the tank unit elements present little interference with liquid flow and drainage. Liquidometer says even very viscous fluids can be gaged without introducing drainage problems in the tank.

The unit is insulated from the tank walls by Teflon spacers. These are sufficiently long to provide adequate leakage paths between active terminals and ground. These same basic insulators are used to separate and support the high- and low-impedance frameworks.

If the system is required to operate in a radioactive environment or at very high temperatures, the insulator material can be changed to ceramic, the company says.

The matrix-type all-attitude liquid-quantity gage is an outgrowth of a research program in capacitance-method fuel-quantity measurement which Liquidometer began at its home plant in Long Island City, N.Y., in 1940.

Space 'Corset'

Garment Designed to Prevent Pilot Injury

Pilots of orbital and re-entry craft who push the panic button in flight may find themselves suddenly grasped in a tight-fitting corset.

Comprising a restraining system of inflatable bladders, netting and straps, the garment is designed to draw a pilot up tight in his capsule to prevent his being injured. He will not be able to move a muscle within seconds after hitting the emergency escape button.

The new gear can be adapted to any of several advanced flight vehicles, such as the *Dyna-Soar,* the B-70 or craft coming in from above the atmosphere. The corset was developed by Goodyear Aircraft Corporation for Wright Air Development Division of USAF's Air Research and Development Command.

The moment the pilot activates the system, straps on his shoes draw his feet inside the escape capsule, bladders around his legs, arms, body and head inflate, and the netting encasing the pilot becomes taut. The capsule doors close, the capsule is pressurized, air-conditioned and ejected. As the unit descends, parachutes open.

The entire operation from button pushing to main chute billow takes only 10 seconds, according to the manufacturer.

Life Sciences Division Set Up at Little, Inc.

Human factors problems connected with man's survival in the Space Age will be investigated in a newly established Life Sciences division of Arthur D. Little, Inc.

The purpose of the effort is "to study intensively the physiological aspects of living in synthetic climates, wearing clothes of synthetic fibers, and eating chemically created foods," according to company president James M. Gavin.

He pointed out that it is also important that the company study the sociopsychological impact of these innovations.

Heading the Life Sciences division and now an ADL vice president is Dr. Charles J. Kensler, formerly chairman of the Department of Pharmacology and Experimental Therapeutics in Boston University's School of Medicine.

He sees his division's work extending from investigations of the direct use of micro-organisms in fermentation processes to the evaluation of exposure risks encountered in space travel.

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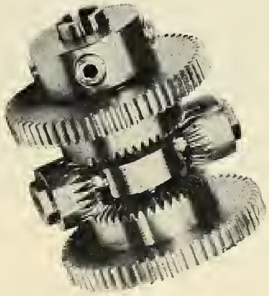
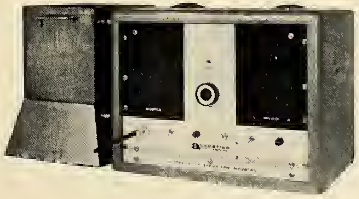


Phoebe Snow (of Buffalo) was the spotless-white symbol of cleanliness in the 90's, when the Lackawanna Railroad was selling train travel. Today, she wouldn't quite fill the bill; this ultrasonically cleaned high-precision differential comes closer to space-age standards.

In just 15 to 30 seconds, with the unit completely assembled, an Acoustica Ultrasonic Cleaner—50-watt pulsing generator, ultrasonic transducer, 1½-gallon tank—literally but safely blasts away every trace of dirt, from even the most minute cracks, hidden surfaces and blind holes. Oil, dust, metal chips, lapping compound, even soils invisible to the eye are removed from gears, shafts and bearings. Acoustica equipment has not only drastically cut cleaning time but has substantially improved reliability in the bargain.



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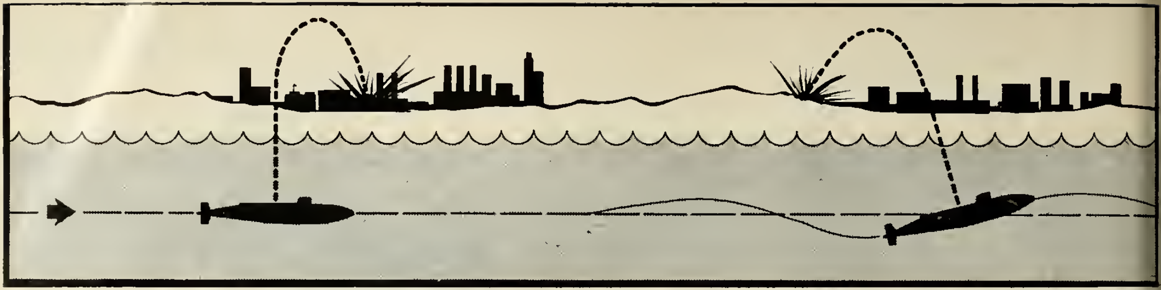


DRAWING illustrates why submarine attitude stabilization is needed during missile launch.

ASW engineering

SAAVS Stabilizes Polaris Subs

Some newly released details of the Kearfott system which controls motion even during launching by salvos

by Donald E. Perry

THE NAVY HAS lifted somewhat the veil of secrecy surrounding the technology of controlling motion during missile firings of the *Polaris* fleet ballistic missile submarine.

The development, by Kearfott Division of General Precision, Inc., is called SAAVS—for Submarine Acceleration and Velocity (measuring) System. This control system can sense and supply corrective signals for misalignments from any source ranging from small deviations caused by slight changes in current to the severe misaligning force created by a missile launching.

- **Background**—The *Polaris* program has presented submarine control designers with unprecedented demands for accuracy and sensitivity. If a sub is to serve as a missile-launching platform, its motion at any time must be known precisely.

At land launching bases, stability is achieved quite simply, by sinking tons of steel and concrete into the earth. But the sea offers no such foundation for a submerged vessel, since constant changes in water currents and temperature, and activities within the submarine itself all interact continuously to change the ship's attitude. Hence the FBM boat requirement that these forces be countered by controls capable of special precision and rapid response.

For, in the moments during and immediately following a fleet ballistic missile launching, the problem of controlling the submarine motion is increased a thousandfold. Tons of matter are being ejected and term compensation affected—all in a few seconds.

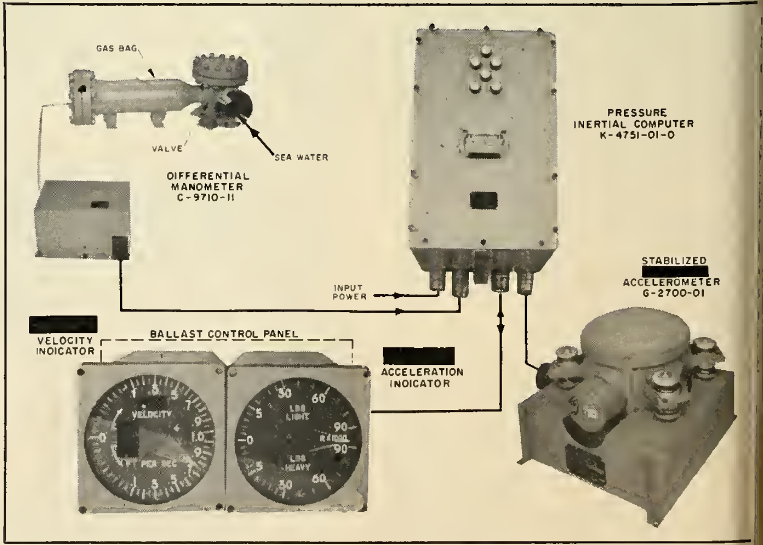
The violent forces caused by the firing set up tremendous disturbances that last for hours. Regular stabilizing controls prevent the vessel from lurching severely.

But the submarine must maintain a controllable attitude, even while launching missiles in salvos, in spite of the repeated concussive forces. Hence it is imperative to stabilize the ship with quick precision during each subsequent firing.

- **Stability with accuracy**—This is where SAAVS—already installed on the USS George Washington—comes in. It detects rate-of-attitude changes by comparing pressure-derived velocity information with inertially-derived velocity. The error signal thus generated i used to provide a long-term correctio to the inertial information.

The system outputs are velocity an acceleration. It features the high resolution, response, and short-term accuracy of inertial systems. In addition according to Kearfott, it has long-ter stability and accuracy not ordinaril associated with a pure inertial system Engineering details, however, are stil classified.

The output of the SAAVS' differential pressure gage is differentiated wit respect to time by means of an electromechanical gating circuit. The outpu of the gating circuit is applied to



KEARFOTT'S Submarine Acceleration and Velocity Detector System (SAAVS). No that classified information in some instrumentation has been blacked out for securit reasons.

wo-channel division servo which com-
ares the two differential pressure read-
ngs taken at a discrete time increment.
utput of the pressure channel is, after
roper scale factoring, a shaft position
nalog of velocity.

Acceleration information is obtained
rom a pitch-and-roll-stabilized acceler-
meter. The output of the accelerome-
er is fed into a scaling amplifier which
rovides a direct acceleration read-out.
t is also fed into an electromechanical
ntegrator whose output is a shaft posi-
ion analog of inertial velocity.

The shaft position representing pres-
ure-derived velocity and the shaft po-
ition representing inertially derived
elocity are then fed into a mechanical
ifferential. The output of the differen-
ial is fed back into the electronic in-
egrator to accomplish the long-term
orrection. In addition, the output of
he differential is fed into a mechanical
ntegrator.

This integrated output is also fed
ack to the electronic integrator to
ompensate for bias shifts and drift.

Navy Streamlines Its Components Monitoring

The number of weapons systems
nder development by the Navy will
rop from 94 to 30 in Fiscal Year
962 budget with Navy laboratories
etting an even stronger role in their
echnical direction.

Actually the big drop doesn't
ecessarily mean the Navy is cancel-
ng more systems development. It's
n action by Vice Admiral J. T.
ayward, Deputy Chief of Naval Op-
rations (Development) to strengthen
is shop by eliminating monitoring of
ardware previously classified as sys-
ems which in reality was only com-
onents development.

The reason is a redefinition of
ystems development by the Navy
hich says simply a system requires
wo or more major components which
re committed to become fleet issue
ardware. Previously such items as
adar, sonobuoys and sonar were classi-
ied as systems when actually they fell
nto a major components category.
uch components development in the
uture will be strictly monitored by
he bureaus with Hayward's shop step-
ing in only in exceptional situations.

Rear Adm. Leonidas D. Coates,
ayward's director of development
lanning, explains that in the past no
ne had a good definition for a system
hich in turn resulted in such a large
umber. As part of the clean-up, Hay-
ard's office now has a three part pro-
ram: Part 1 deals with Weapons Sys-
ems, Part 2A is Exploratory Develop-
nent (actually miscellaneous is a better
vord) and Part 2B is Research.

Grand Central Rocket
REPORT

STRUCTURAL INTEGRITY OF SOLID PROPELLANT GRAINS

The demand for ever larger rocket motors, coupled with the importance of mobility, fast countdown and low cost, steadily increases the importance of solid propellant rockets. To extend the state-of-the-art, Grand Central Rocket Co. has accelerated an important research project on the amount and cause of physical deformation or propellant "slump" in very large solid propellant motors.

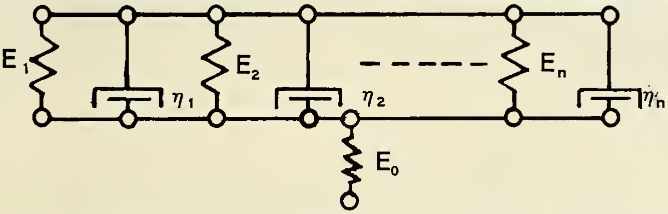
Because the solid propellant is essentially a rubbery, visco-elastic material, it may be deformed—similar to rubber—by time dependent forces. However, its behavior is strongly influenced by conditions of loading and is particularly "rate" sensitive. Under extreme conditions this deformation can cause failures.

The studies by Grand Central Rocket's research team will attempt to establish criteria for the amount of deformation of various solid propellant materials under various combinations of time and force, such as during ignition (short time, large force); in flight (less force, longer time); or during storage (thermal cycling and gravity forces, for a long time).

From the research being conducted, engineers will be able to design large motors which have known values of structural integrity—and resultant operational reliability.

Grand Central Rocket scientists and engineers are developing design criteria based on visco-elastic theory—a basic step necessary before very large missile motors may be designed with high reliability.

The project is another demonstration of Grand Central Rocket's unique capability to handle difficult assignments in the field of rocket motor and propellant research—a capability assured by one of the nation's finest rocket research and design teams.



The physical properties of a generalized linear solid such as the solid propellants under test in the GCR Research Project may be expressed as a mechanical analogue to a first order approximation. A more generalized description may be obtained by using a mathematical analogue.

$$\left[a_n \frac{\partial^n}{\partial t^n} + \dots a_2\frac{\partial^2}{\partial t^2} + a_1\frac{\partial}{\partial t} + a_0\right]\sigma(t) = \left[b_m\frac{\partial^m}{\partial t^m} + \dots b_2\frac{\partial^2}{\partial t^2} + b_1\frac{\partial}{\partial t} + b_0\right]\epsilon(t)$$

Transform techniques are often used to obtain solutions to this mathematical analogue.

Real propellants require non-linear techniques for complete definition. This is being done at GCR by the combined use of a mathematical analogue and experimental methods.

Positions open for visco-elasticians, elasto-kineticists, applied physicists and applied mathematicians

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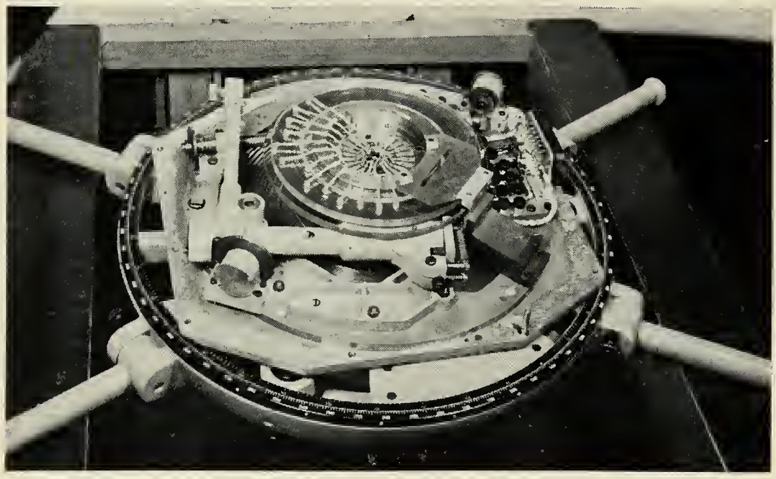
Phasolver Promises Accuracy Plus Low Cost

Analog measuring device by Telecomputing Corp. will be used with big Army radio-telescope Antenna



DIGITIZED AZIMUTH CIRCLES have been developed by Askania-Werke for use with Telecomputing Corp.'s Phasolver. The system will be used with Askania cinetheodolite for instantaneous readout of angular values in azimuth as well as in elevation.

AN EXTREMELY ACCURATE analog measuring device for both linear and rotary application is nearing final development by Telecomputing Corporation, Los Angeles.

Called Phasolver, the unit converts very small mechanical motion to practical electrical phase shifts. For readout, these can be digitized for high accuracy and resolution.

For example, TC says the device is now capable of rotary measurements to within 3 seconds of arc (or 1/432,000 revolution), and with further development it is expected to achieve an accuracy of 1 sec. of arc.

• **First use with antenna**—Phasolver is being developed for use with the Army's 84-ft. radio-telescope antenna at Madkin Mt., Ala. Under a contract awarded by Redstone Arsenal, delivery of the system is scheduled for early 1961.

The TC device will be a principal unit of the digital control and data handling system of the large antenna.

The system was originally developed by TC, but the company says it is being refined through its application to the Redstone dish. It also has been married to an Askania-Werke Kth 58E automatic tracking cinetheodolite at Edwards AFB.

Under a subcontract to TC, Askania developed the digitized azimuth circles for use with Phasolver to provide real time readout of angular values in azimuth, as well as elevation. First prototype has been delivered and is now undergoing test and evaluation by the Air Force.

• **Single-axis rotary measurement**—Two main elements comprise the Phasolver system: a highly accurate electrostatic shifter (or transducer) and the associated electronics and digitizing equipment.

The transducer is attached to the rotating element to be measured. The sensing device is made up of two dimensionally stable non-conducting discs. One of these discs rotates with respect to the other.

Each carries a pattern of conducting metal film on the facing surface. The closely spaced patterns are called the driver and coupler.

There are no physical connections to the coupler disc, which is fixed to the rotating element to be measured. The driver disc is fixed to the supporting frame.

Input and output connections are made to the driver. Energy is coupled electrostatically from the driver to the other second patter producing an output signal. This in turn is directed to the load by output coupling rings in the driver pattern.

The output signal has a constant amplitude and a phase angle, referred to the input signal, that is proportional to the rotary position of the coupler disc. This is accomplished by the intricate configuration of the two disc patterns.

Operation of linear Phasolvers is the same as for rotary measurement—principal difference is in pattern configurations.

• **Many advantages offered**—Its developers say that results of tests so far indicate that the new system is superior to any comparable system existing today.

The company feels the system offers many significant advantages over other measurement methods for reading out mechanical motion:

–No gears are employed.

–Output is uniquely established; accumulators are not required.

–No rubbing parts eliminates wear and increases reliability.

–High speed doesn't hurt discs or readout accuracy.

–No degradation is caused by ferrous metal or stray magnetic fields.

–Concentricity of centers of measured rotary element and Phasolver is not critical.

Currently undergoing further simplification of its associated electronic equipment, the system shows promise of providing a practical, low-cost measuring device which will have no equal in the field, according to TC President W. R. Whittaker.

Using simplified electronics and 4.5-in-diameter discs, TC engineers recently have performed repeatable lab tests with the system showing a resolution of 0.32 second of arc.

RCA Thermionic Tube Works at Low Temperature

A new thermionic tube developed by RCA is said to be the first to operate efficiently from low-temperature sources. Previous types of such heat-to-electricity converters required temperatures in the range of 2000°C. The device operates from source temperatures of 1100°C—equivalent to burning common fuels such as gasoline and natural gas.

Laboratory results are reported to indicate an efficiency of 14% in converting heat energy directly to electricity.

"Why do we like Missiles and Rockets magazine? The answer is simple. Missiles and Rockets deals exclusively with astronautics. Missilery and outer space exploration today is an industry by itself, long divorced from aviation," R. R. Drummond, (left), Chief, Structures Research. He is shown here with Managing Editor Howard and E. L. Strauss, Supervisor of Non-Metals Research, examining extreme high temperature test examples of ceramics and plastics being developed for re-entry vehicles.

WHY DO SO MANY KEY PEOPLE AT THE MARTIN COMPANY READ MISSILES AND ROCKETS

1,087 Paid Subscriptions! In 1959, Martin ranked sixth among all military prime contractors. Its missile/space projects included Titan, Dyna-Soar, and Bullpup, among others. Therefore, it is not surprising to find 1,087 paid subscribers to M/R concentrated at Martin. And since many M/R subscriptions have high pass-along readership, M/R penetration involves many times that number of readers.

Some of the many reasons why M/R commands intense readership at Martin are given in the picture story. They were obtained as a result of a recent visit to the company by M/R Managing Editor, William Howard (insert).

These comments and those of other key readers in missile/space companies show again what M/R has known all along . . . that the missile/space industry is an industry by itself, complete and distinct from aviation . . . with rapidly changing requirements that demand *undiluted, weekly* technical/news reporting. Missiles and Rockets deals *exclusively* with this market—and the deep, penetrating readership and acceptance it has earned document its leadership in the missile/space field.

"News to the missile engineer must be news and must be technical . . . on a frequent basis—not a month old. From concept proven flight—it takes thousands of parts from hundreds of companies to put a bird in the air." J. Lennard, Scientist, Research and Development.

"Today's missile and astronautics engineer must know the products and capabilities of the other companies throughout the industry. Here's where Missiles and Rockets magazine fills the bill."—R. Allen, Scientist, Cryogenics, Research and Development.

British Show New Tactical Missiles

Over 20 guided weapons and drones viewed at Farnborough; Vickers displays Vigilant, new antitank weapon being offered to U.S.

FARNBOROUGH, ENGLAND — Latest entry in the international antitank missile sweepstakes is the Vickers-Armstrong *Vigilant*—a "lowest cost per kill" weapon.

The British War Office is ordering evaluation tests, probably to be held next spring, and the missile also is being offered to the United States. The U.S. Army is debating whether to buy the *SS-10, SS-11,* or the *Cobra* antitank weapon.

Shown off at the 1960 Society of British Aircraft Constructors Display and Exhibition, the *Vigilant* is wire-guided. Overall weight of the one-man-operated system, including launcher box and controller, is 45 lbs. The missile itself weighs 26 lbs. Range is about one mile.

Vigilant is somewhat comparable to Nord Aviation's *SS-10,* which has a launch weight of 33 lbs. and an effective range of 5250 ft.

Other entries in the antitank weapon market are the French *Entac,* Australian *Malkara,* Swedish *Bantam* and the Swiss *Mosquito.*

Missiles generally were more strongly represented at this year's Society of British Aircraft Constructor's at Farnborough Show, than at any previous SBAC Display. There were over 20 guided weapons and pilotless target aircraft of 12 types in the "Missile Park" (20% larger in area than in 1959), the Static Aircraft Park and Exhibition building.

An Avro *Blue Steel* stand-off, powered bomb (or air-to-ground missile) was shown for the first time. Two years ago, an early version of this weapon was flown over Farnborough fitted to a Vulcan, but this is the first time one has been seen on the ground. *Blue Steel* will equip the Royal Air Force's V-bombers and enable them to launch an attack on an enemy target without approaching too closely.

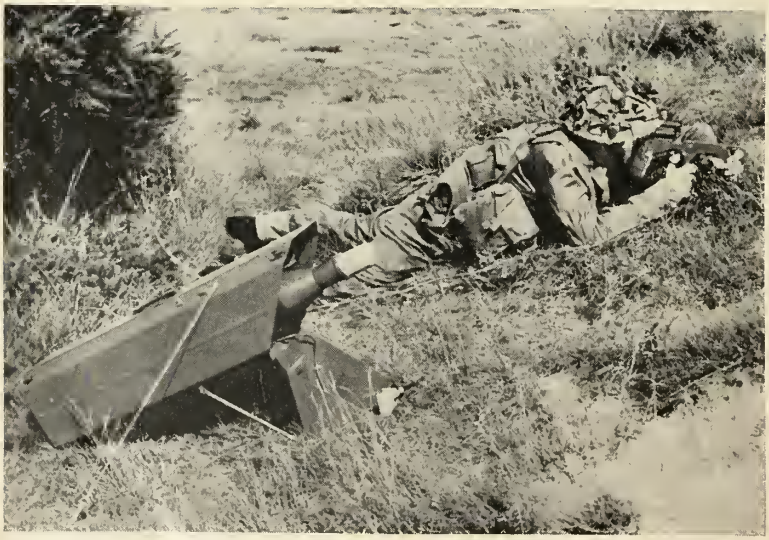
An unusual exhibit was a 60-ft. model of the stern of one of Britain's new County Class missile-carrying warships. On the deck is a complete twin-barrelled launcher containing a boosted *Seaslug,* a display of guidance equipment, a pictorial display of *Seaslug* in action and a sectioned missile. Visitors could operate *Seaslug's* fins by pressing a button. This ship model, built by the three principal *Seaslug* contractors—Armstrong Whitworth, Sperry and the General Electric Company—is the largest ever seen at Farnborough. The Bristol/Ferranti *Bloodhound,* now in service with the Royal Air Force and ordered by Australia and Sweden, is claimed to have the longest range of any semiactive homing missile in the world. Displayed with *Bloodhound* this year was its launcher, part of a launch control post and the target-illuminating radar, elements shown operating in a simulated engagement.

The British Army's 36th A.A. (G.W.) Regiment, Royal Artillery, which is equipped with English Electric *Thunderbirds,* was displayed in the Missile Park. The Regiment also showed a *Thunderbird* battery of four launchers and missiles in the Static Aircraft Park with two launcher control posts, battery command post and tactical control and target illuminating radars.

The Short *Seacat* naval antiaircraft missile has been ordered by the Royal Navy and Sweden and will be adopted by Australia and New Zealand. It is t be evaluated by West Germany, and other Commonwealth and NATO countries are showing considerable interest in this weapon.

De Havilland *Firestreak* air-to-ai missiles were on view fitted to a Javelin Lightning and Sea Vixen—for whic aircraft it is standard operational equipment—in the Flying Display, on th Hawker Siddeley stand in the Exhibition building and in the Missile Park *Firestreak* can be fired at subsonic o supersonic speeds and uses infrare detection to guide it onto its target.

Two pilotless, radio-controlled target drones were shown—the *Jindivik 2* and *C.T.41.* Fairey Engineering is th European agent for the Australian designed and built *Jindivik,* which ha been ordered by the British and Swedish Governments. This target aircraf is powered by a Bristol Siddeley Vipe which gives it a speed of some 60 mph, an operational ceiling of mor than 50,000 ft. and a radius of actio of 100 miles. A *Mk 3 Jindivik* unde development will have a more powerfu Viper. The *C.T. 41* supersonic targe drone is a Nord Aviation developmen for which Armstrong Whitworth ha obtained a servicing and maintenanc license from the French company.



VICKERS VIGILANT has been ordered for trials by the British Army. The wire guided antitank missile is controlled by hand-held sight-controller.

Malkara, the Australian-designed antitank weapon of which there are some 400 on order for the British Army, was exhibited by Fairey Engineering, the company responsible for the weapon in the United Kingdom.

Space research was represented on the Ministry of Aviation stand by the second stage of a two-stage *Black Knight* built to investigate re-entry problems. Two-stage *Black Knights* have reached a height of more than 300 miles and the second stage on view has made a successful re-entry into the earth's atmosphere.

A modification of the Hercules Powder Co. *Altair 248* solid rocket will provide the retropropulsion for the *Ranger* rough-landing moon capsule under development by Aeronutronic Division of Ford Motor Co.

Under a subcontract awarded recently, Hercules will engineer, develop and produce the retro rocket at its Bacchus, Utah, plant. The rocket will have a double-base grain in a plastic-fiber glass case.

Ryan Electronics, a division of Ryan Aeronautical Co., will provide the altimeter that will give the 300-lb. lunar capsule the signal to separate from the *Ranger* spacecraft, a larger structure. The altimeter, its antenna and its support structure, will be mounted on the *Ranger* and remain with it.

For Aeronutronic is building the lunar capsule under contract to the Jet Propulsion Laboratory of the National Aeronautics and Space Administration, which is building the *Ranger*.

NATO, Italian Academy Hold Propulsion Seminar

A Seminar on Astronautical Propulsion was held this week in Milan and Varenna, Italy. The Seminar was sponsored by the Department of Natural and Physico-Mathematical Sciences of the Instituto Lombardo, Academia di Scienze e Lettere, Politecnico di Milano, in collaboration with the NATO Advisory Group for Aeronautical Research and Development.

The following problems were discussed during the Seminar: Problems relating to space mission; physico-chemical problems related to solid and liquid propellant propulsion; design, development and operation of solid and liquid propellant missiles; problems related to nuclear propulsion obtained by fission; solar propulsion problems; ionic and photonic propulsion problems; problems connected with the utilization of plantary atmospheres for the first stage of space missions; magnetodynamic and hyperaerodynamic problems related to space propulsion; future problems in the field of space propulsion.

Among the scientists delivering papers at the Seminar were: Prof. Theodore von Karman, Prof. Luigi Crocco, Dr. Hugh L. Dryden, Dr. Robert W. Bussard, Prof. S. S. Penner, Prof. Martin Summerfield, Prof. Antonio Ferri, Dr. Paul A. Libby, Dr. Adalbert O. Tischler, Jack Buchanan, Prof. E. Saenger, Alfred E. Kunen, Dr. A. E. Von Doenhoff, Prof. Manlio Abele, Prof. Luigi Broglio.

JAPAN'S Kappa 8 being prepared for firing at Akita Rocket Range. Vehicle has a launch weight of 1½ tons, top velocity of 4918 mph. In launching last March, Kappa 8 carried 55-lb. payload to altitude of 124.2 miles.

New DEW Line Station To Use Danish Personnel

Operational and maintenance personnel of a U.S. defense communications terminal at Thule AFB, Greenland, will be virtually all-Danish, according to Federal Electric Corp., service organization of International Telephone and Telegraph.

The new terminal at Thule AFB has been designated Project "Dew Drop." It will provide a new communications link between Thule and the Distant Early Warning (DEW) line rearward communications station at Cape Dyer on Baffin Island. Information from Thule will tie in at Cape Dyer with existing direct communications to North American Air Defense Command headquarters in Colorado Springs, Colo.

Federal Electric will operate the Thule end of the link under terms of a $196,490 Air Force contract.

Russia Reportedly Testing ASW Device in Barents Sea

Russia may be testing in the Barents Sea a new device linked to anti-submarine and underwater missile experiments.

Described in a recent Tass report as a steel, pear-shaped apparatus more than 10 feet high and weighing 5192 lbs., the vessel is supposed to have a submersion depth of nearly 2000 feet and sufficient room for one observer and scientific apparatus.

No explanation of the device's function was given, but the Soviet news agency referred to its ability to measure light at great depth and to remain submerged for six-hour stretches. It was described as having five portholes, a searchlight and photometers designed to measure the intensity of light.

First indications that a device of this type was being tested came earlier this year. But little significance was attached to Tass reports at the time which simply referred to "successful tests in Baltic shipyards."

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soviet affairs

By DR. ALBERT PARRY

A unique way of welding titanium

with the aid of a smelting electrode is claimed by the Soviets. At the special Exhibition of Modern Welding Technology held recently in Moscow, a welding torch resembling a pistol and weighing only 900 grams was shown. It contained an electric motor and a mechanism to handle thin titanium or aluminum wire. Staff members of the All-Union Scientific-Research Institute of Electro-Welding Equipment, where the novel tool was designed, announced that it can be used to weld titanium, aluminum and their alloys anywhere at all—"even at places to which access is difficult." The instrument is described as semi-automatic. The first quantity of these torches was produced by the Leningrad plant "Electric."

Another praiseworthy machine

among the 1000 entries at the Exhibition was, according to the Soviets, the A-372 model for electro-slag welding of thick metal, together with its latest improvement, called A-535. This machine is not really new; its A-372 version has already been shown at the Soviet exhibitions in New York, Brussels, and Marseilles. The scientists and engineers of the Paton Electro-Welding Institute in the Ukraine, where the machine was designed, say that there is no such wonderful instrument anywhere else in the world; that it has been greatly admired by Western experts who allegedly marvel at its ability to weld metals from 15 millimeters to more than two meters thick.

D. A. Dudko, who represented the Ukrainian laboratory at the Moscow exhibition, declared that the A-372 or the A-535 "can weld even thicker constructions, but so far there is no need for this." The speed of welding, no matter how thick the metal, reaches three meters per hour. "Do you realize," Comrade Dudko asks, "what tremendous possibilities are promised by this method of welding?"

Welding by electronic rays in a vacuum

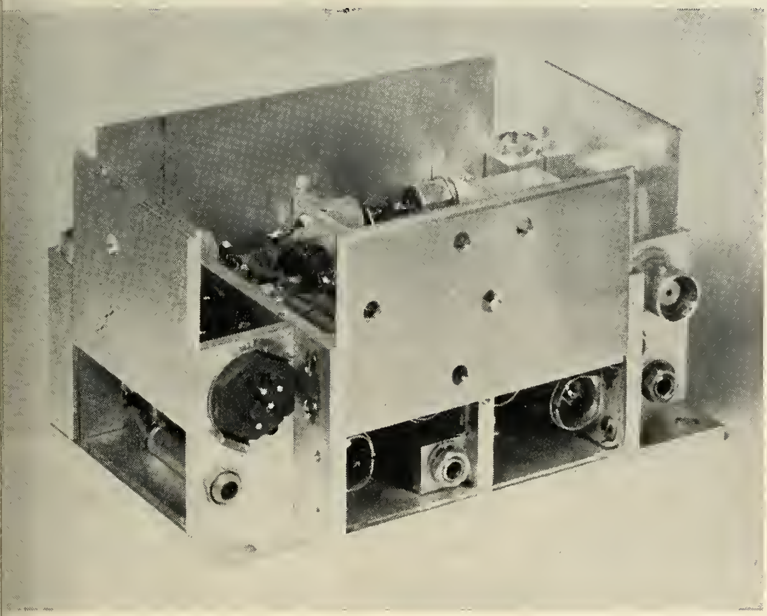
was also represented at the Moscow exhibition. So were cold welding, welding by friction, and other methods, including one piece of equipment capable of producing a new highly intensive source of heat—a stream of flame with temperatures of 15,000° and more. The Soviet directors of the exhibition were particularly proud of the fact that not a single one of the of the 1000 entries had come from outside Russia.

A 'birch-stick' method of steel-drilling

was recently demonstrated at a Soviet exhibition in Prague. This consists of using an ordinary birchwood stick in conjunction with an electric charge. A portion of the wooden stick is covered with a layer of material serving as a conductor of electricity. To the stick-holding instrument a barely visible wire brings an electric current of ordinary tension. A special apparatus makes it possible to concentrate this energy, then—at a necessary moment—to apply it with great force to the process of steel-drilling.

Lightning-like electric blows

punch out the needed holes in the metal with complete ease. Even super-strong slabs of steel cannot resist these blows, the Russians say. They point out that the new method proves one thing above all others: a drilling instrument does not have to be harder than the metal drilled. Boris and Natelia Lazarenko, (apparently a husband-and-wife team) were officially described as the instrument's inventors. They are on the staff of the Central Scientific-Research Laboratory of Electric Treatment of Materials, part of the network of the Soviet Academy of Sciences. Serial production of the new instrument has been entrusted to the Kuibyshev Carburetor Plant in Leningrad. The "birch-stick" method is declared to be especially useful when particularly tiny holes have to be drilled in metals.



High-Powered Tiny Transmitter

A small high-power transmitter, available from Telechrome Manufacturing Corp., produces 4 watts over the 215-260 mc telemetry band. Designed to withstand severe missile environment, the rugged unit is constructed of replaceable circuit modules for easy servicing and maintenance. The Model 1483 FM/FM Transmitter is 1-21/32 x 2-7/8 x 4-1/8 in. in size.

The unit meets applicable portions of Mil-E-5272C and has a frequency stability ±0.005% after normal warm-up.

Spurious radiation is 60 db below fundamental and its total weight is 1 lb.

Circle No. 225 on Subscriber Service Card.

Perceptive Polyolefins

The MIMX Corp. has developed a family of composite polyolefin plastic compounds bombarded with Gamma radiation which are demonstrating unusual physical properties far superior to similar compounds.

Called "MIMX 600," the new compounds possess outstanding resistance to high temperature, acids, solvents, and alkalies.

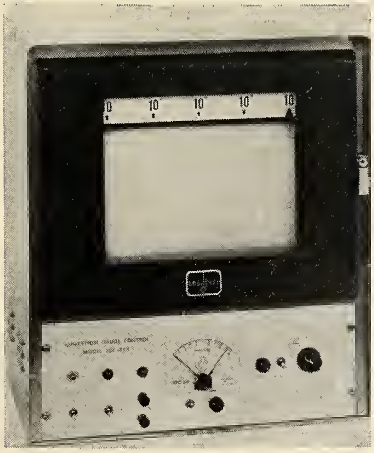
The main feature of the MIMX 600 compounds is a unique "memory" ability which allows them to resume original configurations even after they have been locked into other shapes temporarily.

Circle No. 226 on Subscriber Service Card.

Ionization Gauge Control

A Vacuum Products Ionization Gauge Control IGC-58 designed to meet the most rigid industrial requirements, yet represents the latest developments in the field is being marketed by F. J. Cook Inc. With the IGC-58 it is possible to measure pressures in the high vacuum region of 1 micron to 10^{-9} mm Hg. with automatic switching through five full-scale steps within the range.

The addition of a strip chart recorder coupled to the output of the IGC-58 provides for permanent, accurate and continuous records of vacuum pressures for immediate use or future reference. A design or the IGC-58 provides reference voltages to position the recorder pen, synchronized with the range switch and arranged to automatically subdivide the recorder chart into clearly identified pressure calibrated "bands".



Circle No. 227 on Subscriber Service Card.

Rechargeable Battery Cell

A silver-zinc secondary (rechargeable) battery cell, with high energy-to-weight ratio is being marketed by Cook Batteries.

The storage cell, SC-04, weighs only 0.5 lbs. and takes up less than one cubic inch, including terminals and vent plug. The cells may be interconnected to provide greater capacity.

The SC-04 features far higher energy-to-weight ratio than nickel-cadmium or lead-acid batteries. It has highly uniform performance with low heating and gassing, particularly at large current outputs. Each cell is designed for high shock and vibration resistance.

Circle No. 228 on Subscriber Service Card.

Flow Control Components

Orifices and porous metal restrictors are produced in external configurations conforming to the AN standards or engineered to special requirements by J. V. Houska & Assoc. Applications include accurate flow control at given pressures, damping elements used in control systems and instruments, filters for corrosive media and cryogenics, and ionization fuel cells operating at 1500°F.

These devices, made of metals throughout with the absence of moving parts, exhibit excellent stability and repeatability even under severe environmental conditions.

Circle No. 229 on Subscriber Service Card.

Tantalum Capacitors

Wet-anode tantalum capacitors (M-type), designed to serve in working temperatures up to 85°C, are available in three case sizes from ITT Components Division. The units provide capacitance range from 1.75 to 330 uf over a working-voltage range up to 125 v d-c and maximum surge voltages to 140 v d-c.

Meeting MIL specifications, these units are guaranteed to 80,000 ft. and accelerations of 20 g if limited to 0.1 in. in the range 50 to 2000 cps.

Circle No. 230 on Subscriber Service Card.

Solid-State Servo Drive

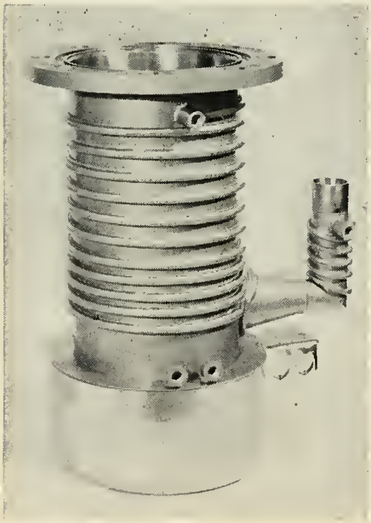
A solid-state, subminiature, servo drive system is available from Solidtronics Div., Electrosolids Corp.

The fast acting, accurate, compact and lightweight unit, consists of a solid-state servo amplifier, a precision gear train and a high-torque servo drive motor. The overall cubic volume of the entire system is but 1.75 in., and it delivers a torque of two (2) inch-pounds at the servo actuating arm from a voltage change of but 0.001 volt. The system's reaction time provides a servo actuator arm speed of 270° of rotation per second.

Circle No. 231 on Subscriber Service Card.

Oil Diffusion Pump

A 6-in. fractionating oil diffusion pump, which provides 70% more speed, 275% higher fore-pressure tolerance, 40% less backstreaming and lower ultimate pressures, is available from NRC Equipment Corp.



The H6-1500 incorporates an improved boiler and a simplified fractionating jet assembly which has three diffusion and one ejector stage. The speed peaks at 1500 liters per second between 6×10^{-5} and 5×10^{-4} mm Hg, and is more than 1400 liters per second from 1×10^{-5} to 1×10^{-3} mm Hg. Fore-pressure tolerance is 700 microns at blank-off and 600 microns at full load.

Circle No. 232 on Subscriber Service Card.

Million-Lb. Liquid Spring

A 1,000,000-Pound Liquid Spring using liquid compressibility is available from Taylor Devices, Inc.

This Liquid Spring is the highest force spring ever produced as a single, self-contained unit. An example of the capacity of this 1-ft.-diameter by 2-ft.-high spring is its capability of supporting three of the largest locomotives—if a way could be found to stand and balance them end to end on this Taylor Liquid Spring.

Circle No. 233 on Subscriber Service Card.

Transistor Commutator

Vector Manufacturing Co., Inc., has designed a Transistorized Commutator for simultaneous sampling of millivolt and volt signals and embodying a modular concept. This Commutator is available for sampling high-level or low-level inputs and is designed for synchronized and simultaneous sampling of intermixed high- and low-level inputs. A wide range of sampling speeds in excess of 25,000 pps, are available for PCM, PDM, and PAM commutation systems. Due to the absence of back current, no specialization of transducer loading effects is necessary.

Circle No. 234 on Subscriber Service Card.

new literature

SHRINK-FIT TUBES—Two brochures available from Raychem Corp. cover the properties and applications of Thermofit. Thermofit is an irradiated, modified polyolefin insulation sleeving which shrinks to a preselected diameter when exposed to heat. One brochure, Thermofit RNF (#203-4), lists all properties, test data, weights and sizes and various applications. The other brochure, Thermofit (RT-2000), describes the use of Thermofit in harnessing and gives some valuable information on harnessing techniques.

Circle No. 200 on Subscriber Service Card.

RECEIVING TUBES—An enlarged edition of the RCA Receiving Tube Manual is now available from the corporation's Electron Tube Division. The Manual has been updated, revised, and augmented. This edition contains technical data for more than 760 receiving tubes, including types for black-and-white and color television, series-string applications, ac/dc equipment, 12-volt car radio receivers, and high-fidelity audio applications (both monophonic and stereophonic). Data are also provided for more than 173 picture tubes, including color types.

Circle No. 201 on Subscriber Service Card.

CERAMIC PROPERTIES—A four-page brochure on precision technical ceramic products for the research frontier industries has been published by the Technical Ceramic Division, Gladding, McBean & Co. The two-color brochure contains suggestions to designers of ceramic products, and pictures and describes techniques of ceramic fabrication. It also features a properties chart and discusses general characteristics of ceramic materials which make them desirable for application to meeting industrial requirements.

Circle No. 202 on Subscriber Service Card.

ENVIRONMENTAL BROCHURE—The latest data on environmental testing and other applications for controlled atmospheric conditions is the subject of 32-page Brochure #600 offered by Webber Manufacturing Co., Inc. One feature is a pictorial color chart summarizing latest known data at altitudes from sea level up to two million feet. It shows specific weight pressure, acceleration of gravity, and molecular weight at various altitudes Other charts give technical information on atmosphere, temperature and humidity.

Circle No. 203 on Subscriber Service Card.

ALLOY DATA—A 44-page publication, Price and Technical Data Schedule No. 14, has just been released b Techalloy Co., Inc. The booklet offer complete data on chemical, physica and mechanical properties of all Techalloy alloys: Monel, Nickel, Nickel Clad Copper, Inconel, Inconel "X" Incoloy, Nionel, Ni Span C, Stainles and Heat-Resisting Steels, Electrica Resistance Alloys, Glass Sealing Alloy and Iso-Elastic. Also included are th Federal, Military, ASME and AST specifications for these metals. Fo completeness, Price Schedule No. 1 lists the recently released ASM spec on Monel, Nickel, Inconel and Incone "X" and ASM specification numbers.

Circle No. 204 on Subscriber Service Card.

PYROMETERS—A 6-page data shee describing Leeds & Northrup Company's line of Pyrometers for temperature measurements up to 7600°F o 4200°C in plant or laboratory is available. The sheet describes and illustrate the construction and operation of th potentiometer-type L&N Optical Pyrometer, graphically showing the application of the "disappearing-filament method of temperature measurement It lists the standard Pyrometers an their ranges, together with accessor equipment for adapting a Pyromete to a variety of specific measurements.

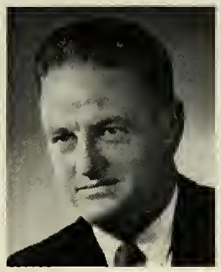
Circle No. 205 on Subscriber Service Card.

INSULATING MATERIALS TESTING—A manual on methods an equipment for testing insulating materials has been compiled by Associate Research, Inc. Sample subjects include determining resistance to arcing of insulating materials, testing insulatin oils for high-voltage breakdown an detection of corona leakage in hig voltage equipment.

Circle No. 206 on Subscriber Service Card.

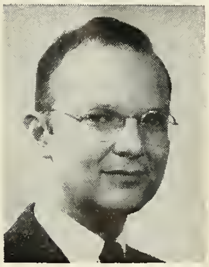
names in the news

RAUSCHENBACH


DUMAS

LOVENSTEIN

BARRY


KECK

G. J. Rauschenbach: Joins the Ford otor Co.'s Defense Products Group as anager of the Huntsville, Ala., office, placing **Leland C. Pleger,** now manager f marketing and planning for Tactical eapon Systems Operations at Ford's eronutronic Division. Rauschenbach was rmerly manager of The Martin Co.'s rporate office in Huntsville.

Roger E. Dumas: Named director of esearch and Development for the Induc- ve Products Division of Statham Instru- ents, Inc. He has been with the company nce 1957, most recently as a project en- ineer responsible for development of gh-accuracy inductive-type linear ac- elerometers.

Allen J. Lovenstein: Former project ngineer for the Crosley Division of Avco orp., appointed manager of market plan- ing and analysis for the Waltham Lab- ratories of Sylvania Electronic Systems.

Robert I. Barry, Jr.: Named assistant irector of construction and installation r Technical Documentation at Page ommunications Engineers, Inc.

Dr. James C. Keck: Elected a deputy irector of Avco-Everett Research Labora- ry, responsible for directing research rograms in plasma propulsion, atomic hysics, electronics and optics. Dr. Keck as been a senior staff member since 1955.

Milton F. Pravda: Joins The Martin o.'s Nuclear Division as chief of system esign. Was formerly with the Knolls tomic Power Laboratories, where he was anager of reactor design for the Atomic nergy Commission's natural circulation actor project.

Robert J. McCardle: Appointed field anager of the *Titan* launching system in- allation of American Machine & Foun- ry Co.'s *Titan* Installation and Activation ivision, Lowry AFB, Colo. Prior to ining the firm he was chief field engineer nd mechanical superintendent for the alph M. Parsons Construction Co.

John V. Sigford: Elected director of inneapolis-Honeywell Regulator Co.'s ilitary Products Group. **David C. Gerrish** succeeds Sigford as manager of the firm's Aeronautical Division.

John R. Bodker: Named chief engineer for Avtron Manufacturing, Inc. Prior to joining the firm as a project manager three years ago, he was manager of the control section in Jack & Heintz engineering department.

Robert Pizzutiello: Promoted to the new post of head of sales for custom microwave components and systems at FXR, Inc.

Roland Louis Guerin, Jr.: Former sales manager for the Clearing and Western Design Divisions of U.S. Industries, appointed sales manager for BMW Manufacturing Co., Inc., responsible for marketing and sales.

Lewis G. Rogers: Named to the newly created position of sales manager for the Industrial & Military Products Division of Bulova Watch Co., Inc.

Dause L. Bibby: Vice president named president of the Remington Rand Division of Sperry Rand Corp., succeeding **Kenneth R. Herman,** who will devote his full time to the position of executive vice president in the Sperry Rand central office.

A. H. Sonnenschein: Appointed assistant to the president of Polarad Electronics Corp. He will also retain his former position as corporate director of planning.

William G. Carlson: Promoted to director of defense and aeronautical projects at Burns and Roe, Inc. He joined the firm in 1943 and was named assistant director of the division in 1956.

Edwin P. Berlin: Former advertising manager of the General Transistor Co., joins Sperry Semiconductor Division of Sperry Rand Corp., as marketing manager.

Howard A. Baxter: Joins Norma-Hoffmann Bearings Corp. as vice president in charge of engineering. He succeeds **Warren D. Anderson,** who will continue as engineering consultant to the president. Baxter was formerly director of technical services with American Machine & Foundry Co.'s Greenwich Engineering Division.

Dr. Kurt Berman: Manager of liquid-propellant rocket engines for General Electric's Rocket Engine Section, appointed to the Research Advisory Committee on Chemical Energy Systems of the National Aeronautics and Space Administration.

Duane C. Manning: Named marketing manager for the Electronics Division of the Elgin National Watch Co.

George P. Sutton: Returns to Rocketdyne as manager of the newly-created development planning organization of the research and engineering department. He left the firm in 1958 to serve for one year as the Hunsaker visiting professor of aeronautical engineering at the Massachusetts Institute of Technology, then as chief scientist for ARPA and division director of the Institute of Defense Analysis in the Department of Defense.

Dr. David S. Potter: Former assistant technical director of the University of Washington's Applied Physics Laboratory, joins General Motors Defense Systems Division as head of the sea operations department.

T. Singelis: Former vice president of advertising, named vice president of marketing services of the Clearing Division of U.S. Industries, Inc. He will be responsible for market research, sales analysis, order and customer service and advertising and sales promotion.

A. E. Schwerin: Named head of the newly organized *Skybolt* re-entry vehicle program office by General Electric's Missile and Space Vehicle Dept. Was formerly manager of the department's Flight Test Engineering operations at Cape Canaveral.

James R. Rowe: Appointed Washington engineering representative for Aerojet-General's Spacecraft Division. Was formerly head of the Advanced Systems department.

Jay B. Ford: Elected director of administration for United States Borax & Chemical Corp.

reviews

THE THEORY OF NEUTRAL AND IONIZED GASES, edited by C. De Witt and J. F. Detoeuf, John Wiley & Sons, New York, 469 pp., $17.50.

Here is a scientific volume of lectures delivered by outstanding physical scientists at the University of Grenoble's 1959 Summer School on Physical Theory. This series of summer schools began in 1951 and after each session a collection of the works has been issued, the first one being on Quantum Mechanics.

The present volume comprises Statistical Mechanics of Interacting Particles by E. W. Montroll; Statistical Mechanics of Non-Equilibrium Phenomena, by L. Van Hove; Theorie Microscopique des Gas Ionises, by J.-L. Delcroix; Plasma in a Strong Magnetic Field, M. Kruskal; Plasma Transport Theory, A. Kaufman; Etudes des Ondes Electromagneticques dans les Plasmas a Partirde l'Equation de Boltzmann, J.-F. Denisse; and Les Plasmas en Astrophysique, E. Schatzman.

This book is not intended for amateurs.

STUDY OF ULTRAHIGH TEMPERATURES, A. V. Grosse and C. S. Stokes. Order PB 161460 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. 26 pp. $1.

This is the final report covering a four year study of various chemical and physical phenomena at temperatures up to 5000°K. The present report summarizes work reported in previous technical notes.

DICTIONARY OF AUTOMATIC CONTROL, Robert U. Bibbero, Chief Engineer, Applied Science, Bulova Research and Development Laboratories, Inc. Reinhold Publishing Corp. New York. 280 pp., $6.

The book covers control theory and basic concepts, computers and data processing, industrial machine and process control, aircraft and missile control and telemetering, and control components and design factors.

It also contains an index of major topics.

AN INVESTIGATION OF INTERMETALLIC COMPOUNDS FOR VERY HIGH TEMPERATURE APPLICATIONS, R. M. Paine and others. Order PB 161683 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. 247 pp., $3.50.

Intermetallic compounds from 35 binary metallic systems were tested for oxidation resistance in dry air at 2300°F. Only high-melting (above 2550°F) compounds were evaluated.

Test samples included aluminides, beryllides, silicides, germanides, zirconides, and a number of miscellaneous compounds. Of the 35 compounds tested, 19 showed sufficient oxidation resistance to be potentially suitable for structural service in air temperature up to 2300°F. The report includes 31 tables and 603 references, plus discussions of the test samples and test results.

ORGANO-METALLIC AND ORGANO-METALLOIDAL HIGH-TEMPERATURE LUBRICANTS AND RELATED MATERIALS—Part 4, H. Gilman and R. D. Gorsich. Order PB 131176 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. 63 pp., $1.75.

The synthesis and preliminary thermal screening for 36 compounds is described. This experiment was conducted to explore the possible application of new organometallic and organo-metalloidal substances as potential high-temperature lubricants and hydraulic fluids.

A table outlining the preliminary screening of 36 compounds for thermal stability is included in the report.

HIGH-TEMPERATURE EVALUATION PROCEDURES FOR LUBRICANTS—PART I: DESIGN DEVELOPMENT AND INSTRUMENTATION OF A 1000°F OXIDATION CORROSION BATH AND 400°F AND 700°F VISCOSITY BATHS, V. A. Lauer and D. C. Trop. Order PB 161506 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. 23 pp., $.75.

An aluminum block bath for use in oxidation corrosion tests at temperatures up to 1000°F is described.

The report also reviews two high-temperature viscosity baths capable of maintaining temperatures of 400° and 700°F respectively. All three baths are designed to develop lubricants and hydraulic fluids for high-temperature service.

STABILIZATION OF FREE RADICALS AT LOW TEMPERATURES—SUMMARY OF THE NBS PROGRAM, Edited by A. M. Bass and H. P. Broida. Order from Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. 110 pp., $1.50.

This monograph reviews the three-year program in free radicals research, initiated at the Bureau in 1956 under DOD sponsorship and terminated Oct. 1, 1959. Purpose of the program was the accumulation of data on the properties of the elusive molecular fragments known as free radicals.

Papers include: Qualitative comments on the physical and chemical processes in trapped radical systems; Experimental aspects of the NBS Free Radicals Program; A survey of theoretical work on trapped radicals at NBS; Low-Temperature chemistry; Methods of production of trapped radicals and properties of radical-trapping solids; Identity and concentrations of trapped radicals; and interactions between trapped species and the matrix.

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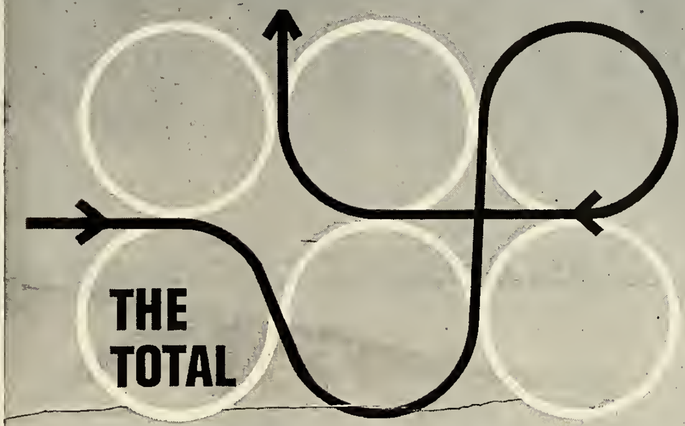

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editorial . . .

The U.N. and Space Regulations

THE UNITED NATIONS, now undergoing its greatest test in the Congo, will inevitably face another, even greater one in the visibly approaching future—the establishment of space law and the regulation of certain space activities.

And, if the U.N. appears to be gaining stature and confidence in its world policing work—the U.N. will need every bit of that stature and confidence, and more, to form and enforce space regulations.

At the recent congress of the International Astronautical Federation in Stockholm, one panel made an attempt to come to grips with the problem of space law. The Russians promptly boycotted the meeting. There was no real agreement among those who did attend—apart from a consensus that it was too soon and too difficult to find a solution.

It may be difficult just now to find the solution. But it isn't hard to see the problem.

That can very easily be with us the moment the Air Force puts a *Samos* in orbit and the reconnaissance satellite makes its first pass over the USSR.

As of now, in light of the U.S. way of conducting space operations, there can be no secrecy when *Samos* is launched. Presumably we will all know the time of launch, the dimensions of the orbit and the ingredients of the payload.

Will *Samos* have a camera? Will it relay back pictures? That's what it is designed to have and to do.

Will our government then release the pictures? Pictures of Russia? With keys, perhaps to airfields, missile sites and submarine pens?

Or will everything be classified under a security veil? It will be a delicate situation. The Russians will know *Samos* is overhead. They will know what it is for.

Since they will know this, which takes *Samos* out of the clandestine area, and since they obviously know the location of their own military installations—then to what purpose security?

There are absolutely no international laws at the moment governing the use of space. There isn't even a good definition of space. The Russians seem to operate on the principle that anything they can hit is in their territory. That's pretty much the way it worked with the U-2.

Will they then remain passive about the *Samos* until they achieve the ability to knock it down?

This is now just an interesting subject for speculation, but when it actually happens it is likely to create a hairline balance between peace and war.

AGAIN, IT SEEMS apparent that international space laws must be established and that they must include certain enforceable regulations.

For there must come a time when nations will not be permitted to toss into orbit anything and any number of things they may wish. Nations will probably have to list their intentions for a year ahead and to abide by a program laid down for the world. Certain projects, inimical to the well-being of the majority of the world, may be outlawed.

This development may not come until long after the time when a reconnaissance satellite has any great significance. But there will be other eventualities—hydrogen bombs in orbit, perhaps.

Logical step-by-step progression would mean the promulgation of space law and agreement on enforcement. It would also mean an absolute requirement for inspection—and certain members won't like that any better then than they do now.

Since this is a world problem, it seems obvious that it must be handled by the United Nations, and faced in that forum very soon.

Clarke Newlon

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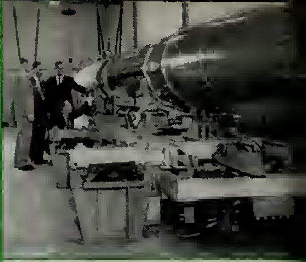

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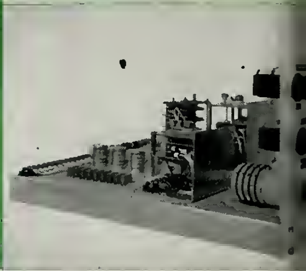

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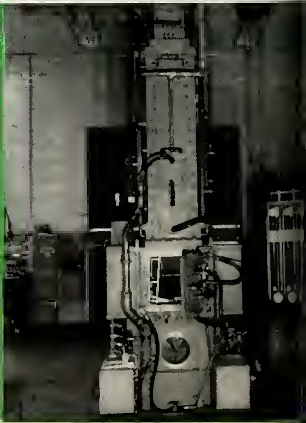

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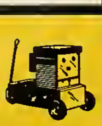
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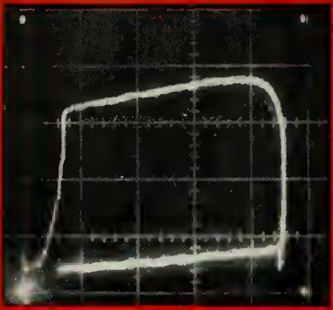

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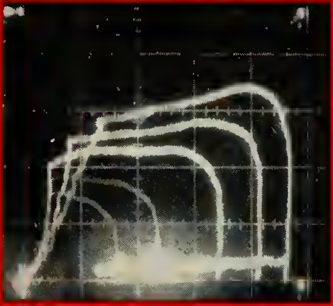

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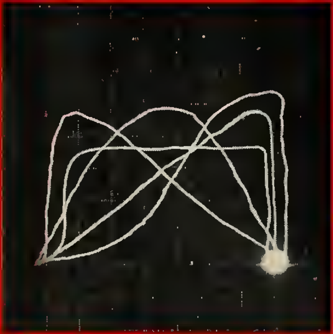

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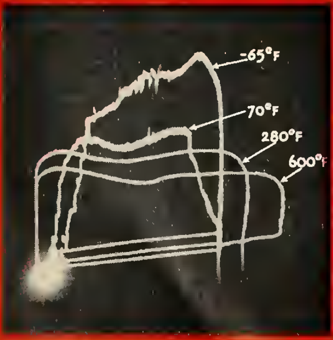

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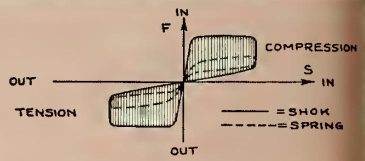

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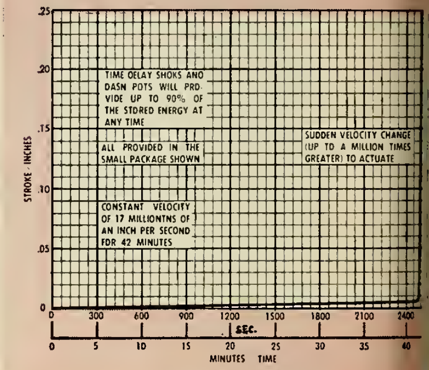

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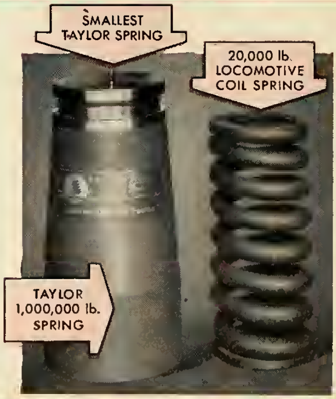
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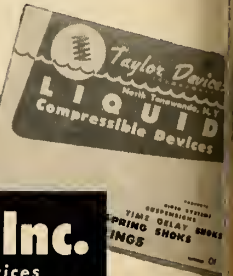

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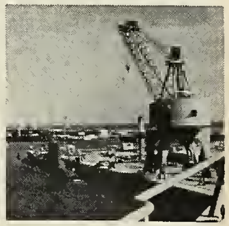
THE COVER



U.S. George Washington takes on Polarises at Port Canaveral for R&D shots (note temporary telemetry mast). M/R photograph by James Baar. See Polaris GSE story, p. 51.

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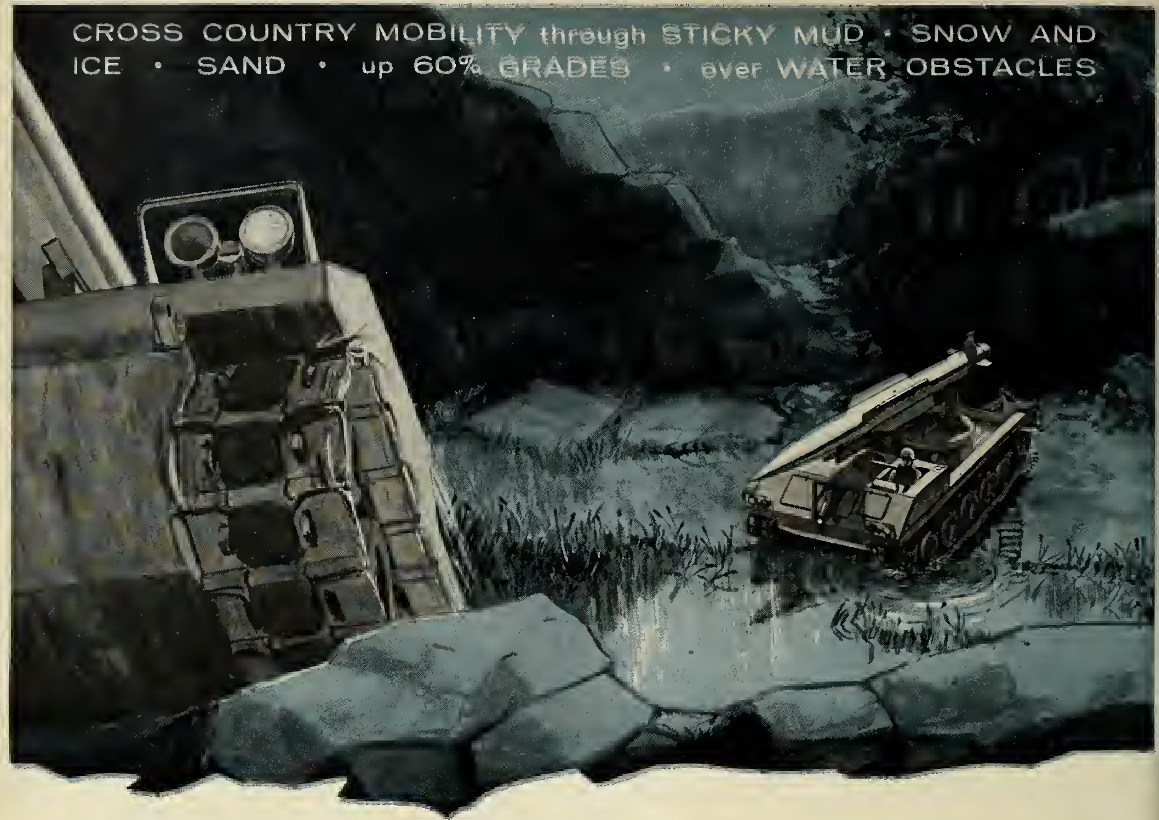
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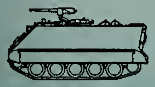
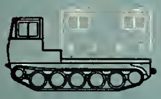
lustrated below are the M113 ad five vehicle adaptations of is basic tracked vehicle. All of e vehicles use the same military andard equipment, including gines, power train, and suspenon components; thus reducing e military logistic burden and &D costs in weapons systems.

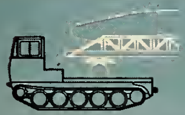


M113 Armored Personnel Carrier

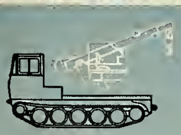
Radar Vehicle



Van-type Vehicle



5th-wheel-type Prime Mover



Utility Crane Vehicle

Missile Launcher

FMC's Aluminum Alloy Welding Techniques Open New Horizons for Structural Applications

Machine welding heavy aluminum armor plate in FMC's Ordnance Division's shops.

Food Machinery and Chemical Corporation's recently developed welding techniques make economical heavy aluminum weldments possible. High strength, low weight, gas and liquid tight construction are a few of the characteristics available through modern welded aluminum fabrication. These techniques are ideally suited to the construction of vehicles — landing craft, barges, containers — on an economically sound basis.

FMC's aluminum welding capabilities are the result of extensive research and development work performed in cooperation with military agencies to develop reliable, economical welding techniques for the production of the aluminum M113 Armored Personnel Carrier. Thousands of pounds of various aluminum alloys were formed, welded, machined and tested to select the best alloys and fabrication methods. Over a score of prototype M113's were then constructed and subsequently tested by military agencies to substantiate the vehicle's design and construction.

The economy realized through FMC's development of welding and fabrication techniques is an important factor...making the cost of the aluminum M113 competitive with the M59, its steel predecessor. Welding costs for this all aluminum vehicle were reduced through the use of—

Optimum joint geometry
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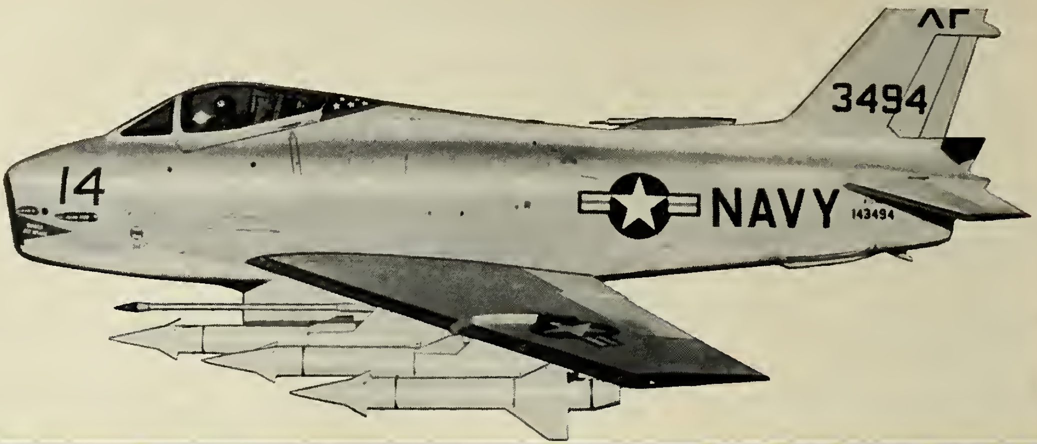
The new aluminum welding techniques developed for the M113 program and vehicle production, illustrates FMC's fully integrated capabilities and facilities.



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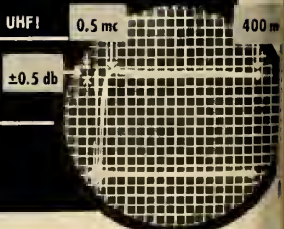

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letters

Judicious Reader

To the Editor:

I congratulate you on a fine magazine.

I am writing to say I especially enjoy your coverage of "blue skies" projects such as the recent coverage of NASA. In addition, peripheral subjects such as mechanical translation (M/R, July 11) deserve treatment.

Also, your coverage of foreign space projects is most informative.

A contented subscriber.
Lester W. Bunning
Hawthorne, Calif.

Optics Report Pleases

To the Editor:

Congratulations on your Special Report—Missile/Space Optics. We found it very informative and enlightening.

On page 31, we were happy to read your report on Avco's installation at Eglin Air Force Base. In the second paragraph you mention that there is a 0.50 usec Kerr Cell Shutter installed as part of the system. This actually is a *.05 usec* Kerr Cell Shutter, and it can photograph projectiles traveling over *14,000 feet per second,* not the 1400 feet per second that you report.

These projectile speeds are really very little challenge for a Kerr Cell Shutter of this kind. The significance of the whole system is, as you pointed out, wrapped up in the light source synchronization problem.

I appreciate some of your problems in publishing an issue of this complexity. I did feel, however, that you would not wish these typographical errors to slip by unnoticed.

Richard J. Burns
Research and Advanced
Development Division
Avco Corporation
Wilmington, Mass.

To the Editor:

Congratulations on your massive reporting job in the long-neglected field of optics (Special Report, M/R, Aug. 22). With the more glamorous areas of rocketry and space exploration getting all the play, optics has obviously suffered to the extent of becoming a backward science. Certainly, you have done . . . a real service by pinpointing an emphatic and continuing need for highly developed optic tools in the Space Age.

John L. Hammet, Project Engineer
Page Communications Engineers, Inc.
Washington, D.C.

Vidya and the OAO

To the Editor:

I read with a great deal of interest the excellent report covering the Orbiting Astronomical Observatory ("NASA Eyes Standardized Satellite," M/R, Aug. 8, p. 25).

We at Vidya, Inc., are indeed proud to be part of the competition which will be certain to bring to the U.S. tremendous prestige and many valuable and perhaps world-staggering technological discoveries about the nature of the cosmos.

I would like to point out, however, a misprint in your article which is certain to cause confusion if it is not corrected. This occurs in the fifth paragraph on page 27, where the article reads, "Douglas Aircraft/Itek Corp./IBM/Vidya of Massachusetts Institute of Technology." This should show Vidya, Inc., and Massachusetts Institute of Technology as separate team members—so that the entire team, which we are sure is one of the most competent ever to be assembled, is Douglas Aircraft/Itek Corp./IBM/Vidya, Inc./Massachusetts Institute of Technology.

William E. Orr
Director of Programs
Vidya, Inc.
Palo Alto, Calif.

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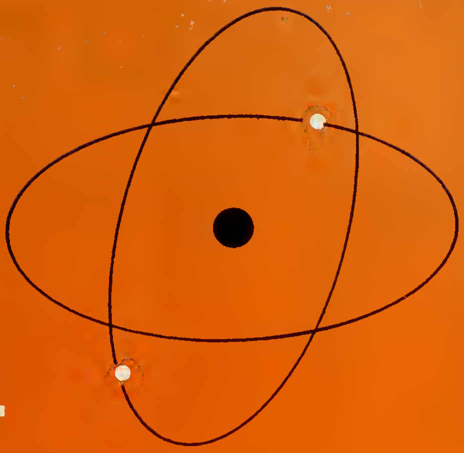

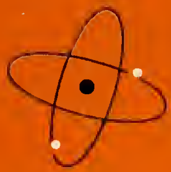

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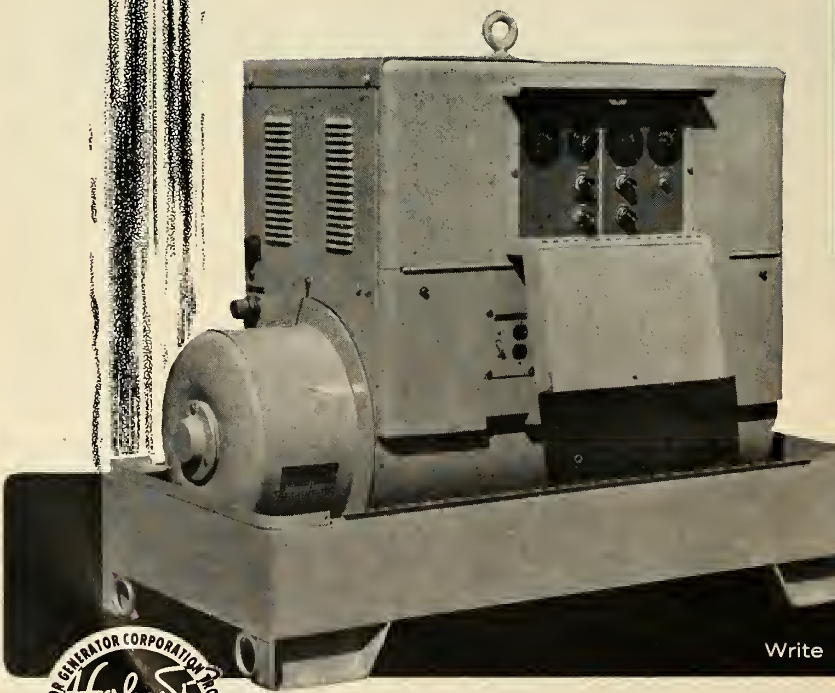

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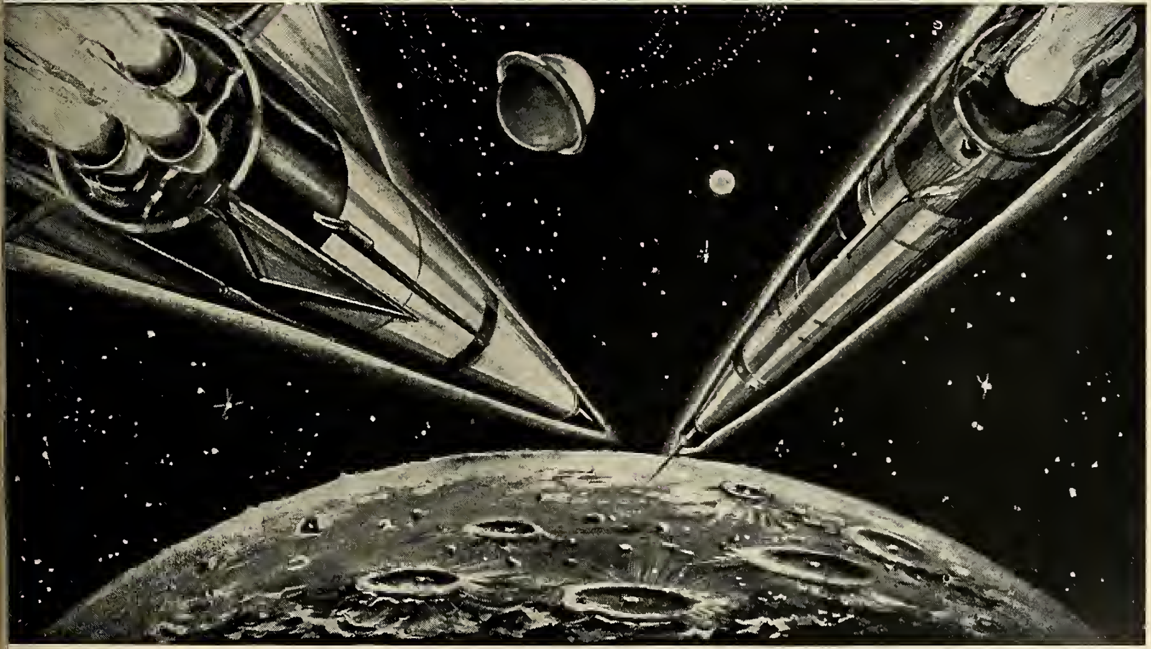

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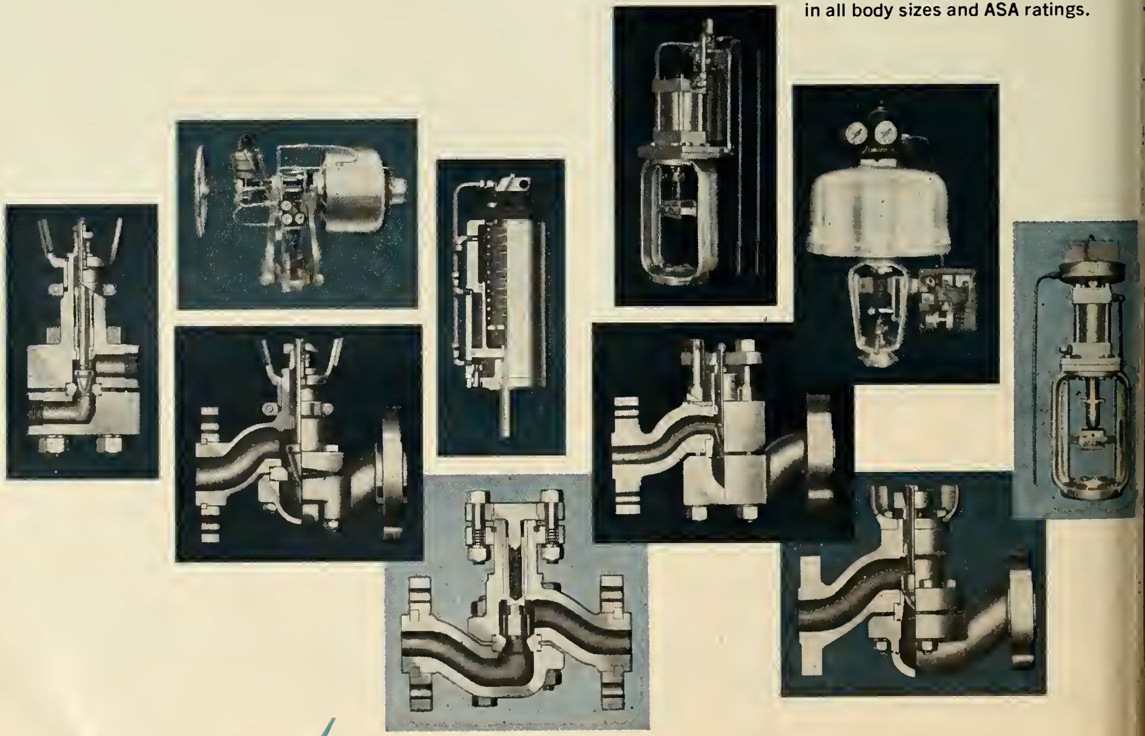

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The Countdown

WASHINGTON

SPACE BUCK PASSES ON

The spidery problem of defining clear-cut national objectives in space exploration is being passed on to the next Congress and Administration. Until these objectives are determined, all efforts at trying to eliminate duplication on an administrative level appear headed for failure. This includes a newly set up DOD-NASA "Aeronautics and Astronautics Coordinating Board" which is to fill the void created by Congress when it allowed Revision of the Space Act to die. Lacking any clear guidelines, the Board is expected to find the going just as mushy as have various other committees who grappled unsuccessfully with the problem.

Pressure for Samos Increases

Several current Pentagon staff switches in the Air Force appear to be intended to step up the *Samos* reconnaissance satellite program. The AF seemingly is bent upon making *Samos* operational at the earliest possible moment. Contracting in the program should take a jump shortly.

Leapfrogging Dyna-Soar

Several companies are trying to leapfrog the *Dyna-Soar* program with proposals for more advanced follow-on military spacecraft. One the AF is understood to be looking over seriously is an idea for a spaceship powered by a ramjet—both during early flight in the atmosphere and in space.

No Delay in Polaris Deployment

Speculation that a failure in a submerged *Polaris* launch Sept. 13 from the Patrick Henry will delay deployment of fleet ballistic submarines is said to be unfounded. The abortive firing reportedly was a random failure in the missile, which would not keep the first *Polaris* sub, the George Washington, from going on station late next month.

Minuteman ALBM Study

Cut-down *Minuteman* slung from the B-70 is being studied for the Air Force by North American Aviation as a possible ALBM. The *Minuteman* with a reduced first stage would still have a considerable range advantage over the *Sky Bolt* if fired at altitude.

Aeros to Watch Storms

The *Aeros* 24-hour weather satellite will be equipped with a Zoomar-type TV camera of variable focus for taking close looks at developing storm systems and hurricanes. *Aeros* will supplement a system of polar-orbiting *Nimbuses,* which will be launched about twice a year.

On the Pad

The Air Force is ready to flight-test its version of the *Scout*—the 609A . . . NERV shot at Pt. Mugu this week will be NASA's first shot down the Pacific Missile range.

INDUSTRY

STL Losing 10% to Aerospace

Only about 10% of Space Technology Laboratories' total business is being turned over to the Air Force's new management firm—Aerospace Corp. STL officials say 50% of their technical work will continue in the ballistic missile programs. As a strictly private company, STL expects this year to net $2 million on $85 million sales.

X-15 Flight Nears

First flight of North American Aviation's *X-15* with the 50,000-lb.-thrust Thiokol XLR-99 engine is now set for the last week in September. The test slipped from earlier this month when the engine had to be removed to replace a corroded hydrogen peroxide tank.

GSE Spending on Rise

Analysis of military gound support equipment needs shows an expected increase in the FY '62 budget by about $1 billion in this category. Mobility is the prime factor (See p. 25).

Papa Bear is Big

The Air Force discloses that its "Papa Bear" liquid hydrogen plant operated by Air Products Inc. at West Palm Beach, Fla., has a 60,000-lb. daily capacity. This is almost five times that of the next largest known plant—Linde's at Torrance, Calif.

INTERNATIONAL

Hope Rises for Space Program

The British government now appears to have made up its mind to approve a space research program, probably using *Blue Streak* and *Black Knight* rockets. Launching of the first British satellite is expected to cost between $220 million and $330 million. If the plan goes through, the Spadeadam Rocket Establishment would be rescued from oblivion (see p. 52).

Swedish Space Probe

The Swedish Committee on Space Research may buy Atlantic Research Corporation's *Arcas* rocket or the equivalent. Its space research projects include high-altitude turbulence, radio-wave absorption, proton flux, and electron density measurements.

The Overseas Pipeline

Engineer V. Gencic of the Yugoslav Astronautical Society says they will soon decide whether to buy Japanese *Kappa* rockets for their experiments or continue negotiations elsewhere . . . Friden International, S.A. is the California firm's new EFTA subsidiary in Fribourg, Switzerland. Highly successful defense and commercial systems here and increased sales abroad prompted the move.

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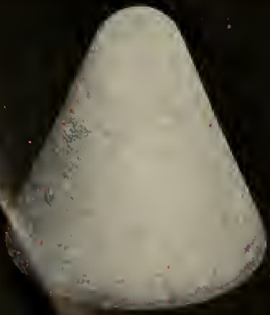

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FORECAST

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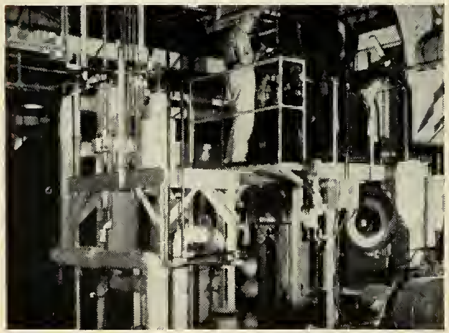

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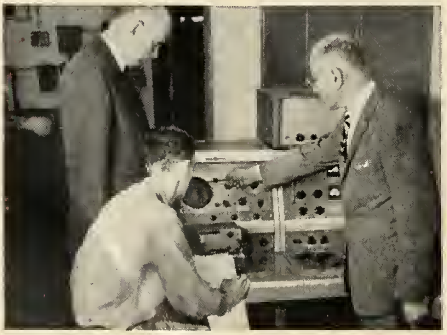

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In solid propellant systems, General is conducting intensive investigation under Government contract. Incorporation of the fluorine atom in the oxidizing molecule is part of this research.

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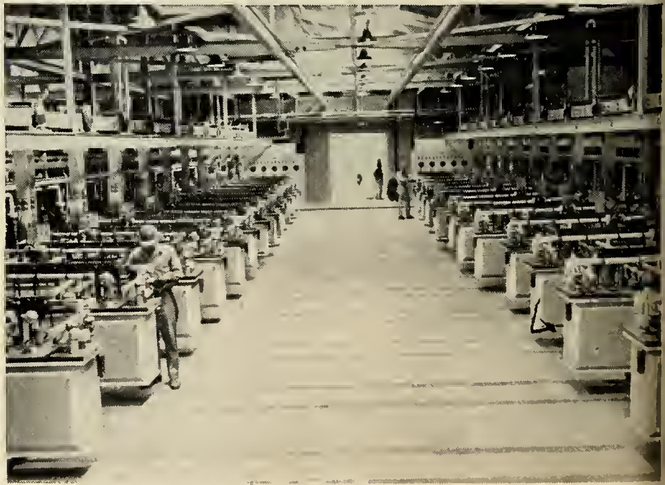

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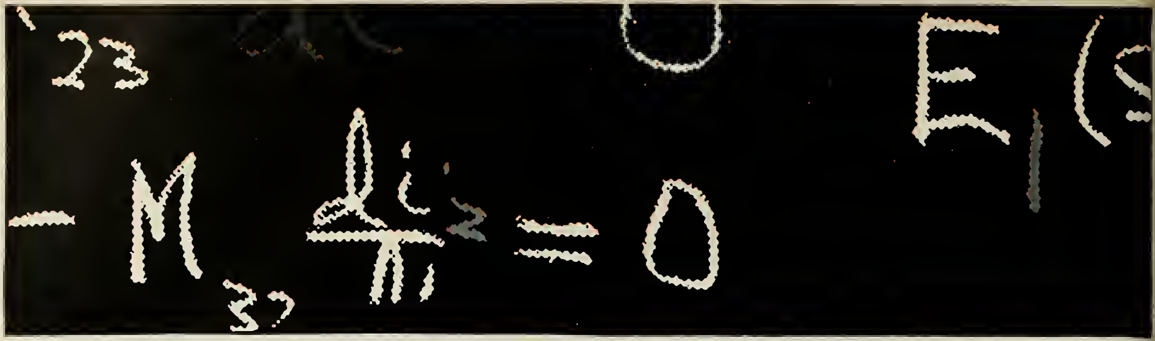

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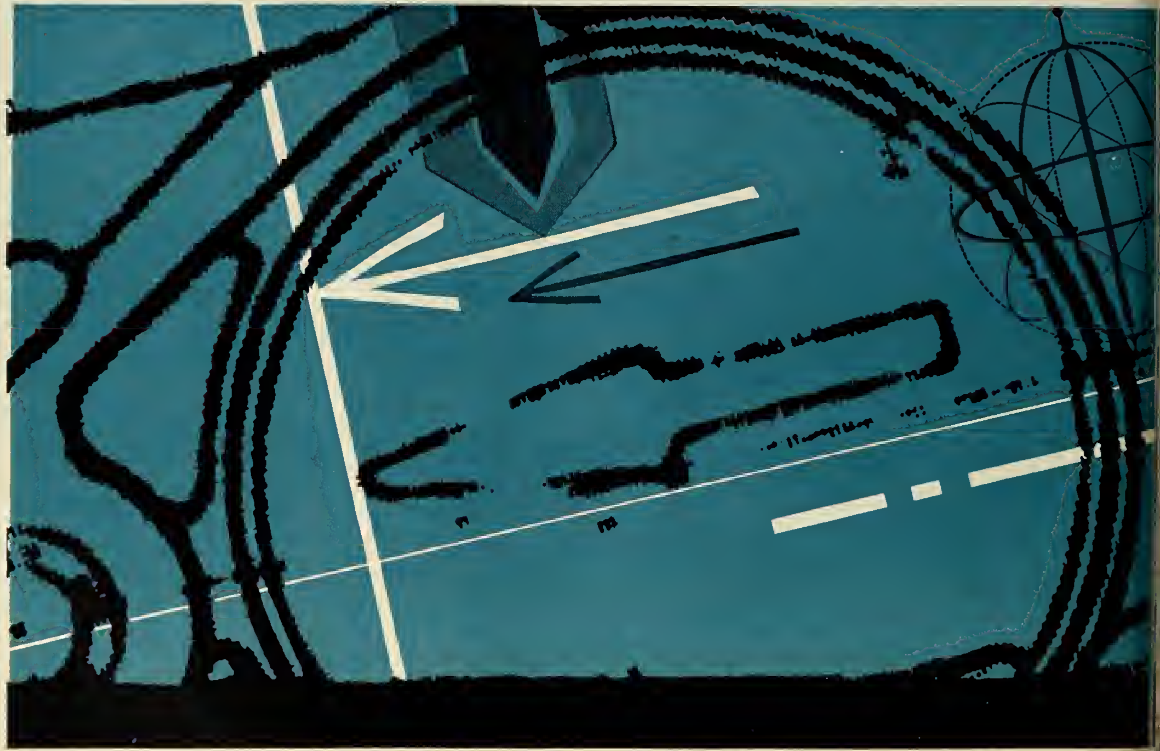
AC QUESTMANSHIP



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Hard-based Minutemen vs. Mobility

Backers of fixed bases claim that an adequate force of Minutemen would cost far less than Polarises

by James Baar

THE FIXED-BASE *MINUTEMAN* is challenging the running trend toward missile mobility.

All signs point today toward the challenge becoming a heated inter-service fight that will be one of the first major issues to confront the new Congress and new Administration in January.

At the center of the controversy are the long-range plans for construction of a 45-boat fleet of *Polaris* submarines and a vast complex of hundreds of hardened *Minuteman* sites.

At stake are major decisions affecting the nation's security in the mid-1960's and beyond.

The trend toward mobility in missile systems has become an onrushing wave in the last year.

The Army is putting on wheels or tractor treads any missile that a GI can't carry on his back. The Navy has always had all of its missiles mobile. The Air Force's new *Sky Bolt* will be launched from bombers and other aircraft and a sizeable portion of the *Minuteman* force will be on trains.

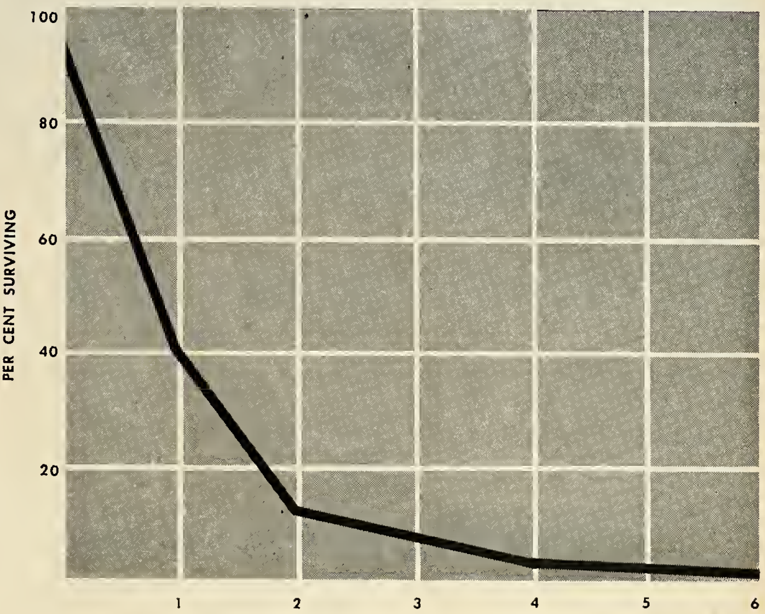
But mobility is a factor that greatly complicates a missile system—particularly for big strategic missiles. Costs rise sharply.

It is on this count—money—that the fixed-base *Minuteman* is making its principal challenge. There are other counts. But money is the main one.

• **Case for mobility**—The advocates of mobility argue that the day of the hardened fixed missile site will be brief at best.

The argument hangs on the accuracy of Soviet ICBM's. As that accuracy increases, the number of missiles that would be needed to knock out a hardened missile site will markedly decline. The vulnerability of hardened missile sites will rise accordingly.

For example, assume a Soviet attack on a hardened missile site built to withstand overpressures of 100 lbs. psi. Assume also that the Soviet attack will be made by ICBM's carrying 10 megaton warheads. And that it has 100% reliability.



Survivability of U.S. Missiles

MINUTEMAN'S CHANCES of surviving an attack by one or more 10-megaton ICBM's with a CEP of one nautical mile. Each Minuteman site has been hardened to 100 psi. The ratio and percentages given are applicable to a force of any size.

If the Soviet missiles' CEP—the radius within which 50% of the missiles can be expected to fall—is three miles, 14 would be needed to ensure a knockout within a probability of 90%. But cut the CEP to two miles: Only six missiles would be needed. Cut it to one mile: then only two would be needed.

A number of experts have predicted that the Soviets can be expected to have a one-mile CEP by about 1963. If they are right, a two-to-one attack on U.S. *Minuteman* sites would destroy some 80% of the force.

On the other hand, mobility advocates contend that such missile systems as the submarine-launched *Polaris* and the train-launched *Minuteman* are far less vulnerable to improvements in Soviet accuracy.

Unless there are great and unforeseen improvements in underwater detection systems, the *Polaris* submarines are considered extremely difficult to locate and destroy on an individual basis. They are considered all but invulnerable to mass attack.

The *Minuteman* trains also are considered extremely difficult to knock out. However, because they can be seen and because they are tied to the railroad net, it is conceivable that they could be destroyed on a mass basis if the Soviets were willing to pay the tremendous price of pattern bombing 100,000 miles of railroad—the trackage within *Minuteman's* range of Russia. But this is not considered likely.

• **Case for hard bases**—Advocates of hardened bases concede all of this. They center their case primarily on cost —and numbers.

The Navy has estimated that the entire cost of a 45-submarine *Polaris* program will be $8.6 billion. This is a

Mathematics of Survival

How to determine the approximate survivability of a missile system.

The fraction of a missile force expected to survive an attack can be arrived at by this equation:

$$S = (1-k)^{rE/M}$$

S is the fraction of the force expected to survive.
k is the probability of a one-shot kill.
r is the reliability of an enemy's missiles.
E is the number of attacking missiles.
M is the number of missiles under attack.

To determine the value of k another equation is needed. It can be expressed as:

$$k = 1 - (1/2)^{R^2/C^2}$$

R is the radius of the effect of a particular attacking warhead. This can be determined from the unclassified AEC-DOD handbook on nuclear effects.

C is the Circular Probable Error.

The number of missiles that would survive an attack can be determined by multiplying both sides of the survivability equation by the size of the force under attack. Thus:

$$A = MS = M(1-k)^{rE/M}$$

total figure including $2 billion for R&D.

Such a program would produce a fleet packing 720 missiles. The all-inclusive cost of sending each missile to sea would be $12 million. However, the cost of each missile in the later submarines minus R&D and other one-time costs would be about $8 million.

Figures on the much newer *Minuteman* system are not as complete in the public record or as hard. However, the Air Force has estimated that the cost of each *Minuteman* in the ground will be about $2 million minus R&D.

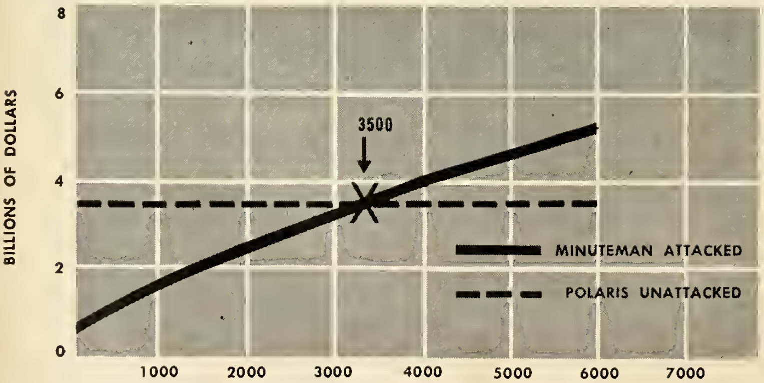
This is the figure that high-ranking Air Force officials have in mind when they speak of *Minuteman* being an "economic breakthrough." Some authorities contend the figure is low. However, this is still to be determined.

Given the $2 million *Minuteman*, the hardened base advocates contend that the nation can buy a larger surviving retaliatory force than if it bought either *Polaris* or train-launched *Minuteman*.

The secret is numbers—and the cost of surviving missiles. It works like this:

Give the Soviets a one-mile CEP. Give them a two to one superiority over the United States in the number of missiles. Give then a 10-megaton warhead on each. Give them an overall operational reliability of 80%.

An all-out attack on hardened and dispersed *Minuteman* sites with such a force would result in knocking out nearly 80% of the *Minutemen.*



Cost of 300 Surviving Missiles

POLARIS VS. MINUTEMAN on the basis of cost and survivability. Here 100-psi Minuteman sites are attacked by 10-megaton ICBM's with CEP of one nautical mile and reliability of 80%. The number of Minutemen on the curve represents the initial force required if 300 are to survive attack by the increasingly large enemy force. The Polaris force at sea is not attacked. Cost curves do not cross until the Minuteman force reaches a total of 3500 missiles.

• **Survivability's cost**—But if the *Minuteman* force numbered 1200, a retaliatory force of 300 could be expected to survive. The cost of such a force would have been about $2.4 billion.

The cost of a similar force of 300 surviving *Polarises* at sea would be about $3.6 billion.

The *Polaris* figure is based on the assumption that two-thirds of the *Polaris* fleet will be at sea at any one time. Furthermore the assumptions are made that the submarines in port are attacked and destroyed, but the submarines at sea are not attacked.

Operating the same formulae, approximate cost figures can be obtained for any size of friendly and enemy forces and any size of surviving force required.

It is not until the initial *Minuteman* force has reached 3500 missiles that the cost of *Minuteman* and *Polaris* becomes equal for a surviving force of 300. Beyond 3500, *Polaris* becomes cheaper.

On the basis of these figures, two conclusions can be drawn:

–Hardened *Minuteman* sites in large numbers can provide the nation with a sizeable, surviving retaliatory force regardless of gains in the accuracy of Soviet missiles now expected.

–*Minuteman* appears to be a much less costly system than *Polaris.*

• **Something to ponder**—However, these conclusions do not take into account several important matters.

One is the time between now and the period in late 1963 when *Minutemen* are scheduled to be available in large numbers. During this period, *Polaris* is the only mobile ballistic missile system available. Thus any decision as to whether more *Polaris* or *Minutemen* should be built is something that can affect only the mid-60's—not the missile programs of the next few years.

Another important factor is the argument that the installation of large numbers of hardened sites will cause the Soviets to build even larger numbers of ICBM's that would be aimed at the American homeland.

Also, there is the contention that ultimately ICBM accuracies and warhead sizes will improve to the point where direct hits are assured.

And, finally but far from last, is the strategic question of how many surviving strategic missiles the nation needs.

All of these factors are threads in the overall debate.

Little about it is simple. Much depends on the right decisions being made in the coming year. ⌘

Market Forecast: Up 25% in FY '62

Outlook for missile GSE is $1 billion more than this year; NASA expected to add $250 million for space support

HEAVIER EMPHASIS upon mobility for ICBM's and tactical missiles will be reflected in FY '62 military budget requests for ground support equipment.

A forecast by the M/R Research Department for the next fiscal year indicates a total missile GSE market topping $4 billion—up $1 billion over FY '61. Moreover, an additional $250 million is expected to be spent by NASA supporting space flight programs.

Biggest question mark in the forthcoming budget to be presented to Congress in January is the Navy's request for *Polaris* submarines.

Chief of Naval Operations Arleigh Burke has indicated a desire for 12 fleet ballistic missile subs costing an estimated $1.3 billion. However, the actual request is presently expected to be between six and nine. *Polaris* subs in the water and in varying stages of construction (including those for which only long leadtime items have been authorized) now total 19. The Navy wants a total of 45.

New money is expected to be earmarked for developing railroad mobility for the Air Force's *Minuteman* ICBM, estimated to cost $4.8 million per missile aboard a train. The AF eventually may buy up to 100 rail-borne *Minutemen* trains (see p. 29). The AF also is stepping up GSE for missile-carrying aircraft.

The largest single GSE item in the coming budget, however, will continue to be the fixed base-building program for *Atlas* and *Titan* and the silo-launched *Minuteman*. The AF is spending $696 million in FY '61 to construct ICBM bases and $802 million to equip them and support other missiles. With the ICBM base building program nearing the half-way point, these figures should rise in the coming year—particularly with both presidential candidates pledged to greater defense spending. Pressure also will be on to close the Missile Gap by speeding up the completion of the bases.

Missile Support Equipment Procurement
(millions of dollars)

	1960	1961 (est.)	1962 (est.)
Air Force	$642.5	$802	$850
Army	421	455.5	500
Navy	500	553	575
ICBM Bases	550	696	720
FBM Subs	378	548	740

Note: Above totals do not include communications, warning systems or Navy missile ship conversions.

• **Total mobility**—With the Army, the emphasis has shifted almost totally to mobility. Buys of missile carriers such as the M-113 (for the *Pershing, Mauler*, etc.) are expected as various new missiles reach production status.

High on the Army's priority list is a mobile battlefield antimissile system. Although contracts are still only about to be let for studies of such a system, the Army can be expected to move quickly on this project once it decides what it really wants.

Indicative of the Army's all-out effort to obtain complete "shoot and scoot" capability was its decision in FY '61 to purchase 18,000 tactical trucks and increased air support. It also is making the *Nike-Hercules* air/missile defense missile mobile.

Still hanging fire is the decision to proceed with production of the *Nike-Zeus* A-ICBM. The Army is being obliged to wait until *Zeus* is tried against *Atlases* fired into the Pacific next year before it can expect a go ahead. Even at that late hour, *Zeus* could command a multi-million supplemental appropriation for its GSE.

An analysis of GSE spending shows that the electronic share of all military equipment is now running close to 90%, with the remainder classified as mechanical and automotive.

The Defense Department in the next budget is expected to ask for continuing high appropriations for various communications and warning systems, including BMEWS, SAGE and the Army's Missile Master. But a big upswing undoubtedly can be anticipated in satellite reconnaissance systems—both *Samos* and *Midas*. These two systems, expected to progress materially next year toward operational status—based on successes with the *Discoverer* and *Tiros* programs—will require major amounts of electronic GSE for interrogation, data reduction and communication.

NASA also is rapidly becoming a major market. Officials estimate that the space agency will spend an average of 25% of its annual budget in the future with industry on GSE.

Outside of R&D, little GSE money is being allocated beyond *Mercury* for either military or NASA manned space missions. But, as the U.S. space program slowly gathers momentum, this is rapidly emerging as the GSE market of the future.

• **Long-range outlook**—The Air Force's *Dyna-Soar* program is expected to approach nearly $1 billion for R&D alone, including GSE. And follow-on R&D programs for military spacecraft are already under consideration.

NASA's *Apollo* manned spacecraft program also is scheduled to get under way next year, along with other new NASA space projects.

Moreover, a number of Pentagon officials are looking toward development of advanced missile defense and space station systems. Such space stations would be both manned and unmanned.

But probably the heavies long-range thinking in GSE is being done by both the military and industry in the area of equipment that will be needed for establishing bases on the moon in the late 1960's or early 1970's.

Mobility Adds to Support Problems

Trend toward big-missile mobility vitally affects design, costs and maintenance of support equipment; services take different approaches based on missions

by Hal Gettings

THE ARMY, Navy, and Air Force agree on at least one thing: making missiles mobile costs money. In general, crews must be larger, maintenance is more of a problem, and there are rigid limitations on size and weight.

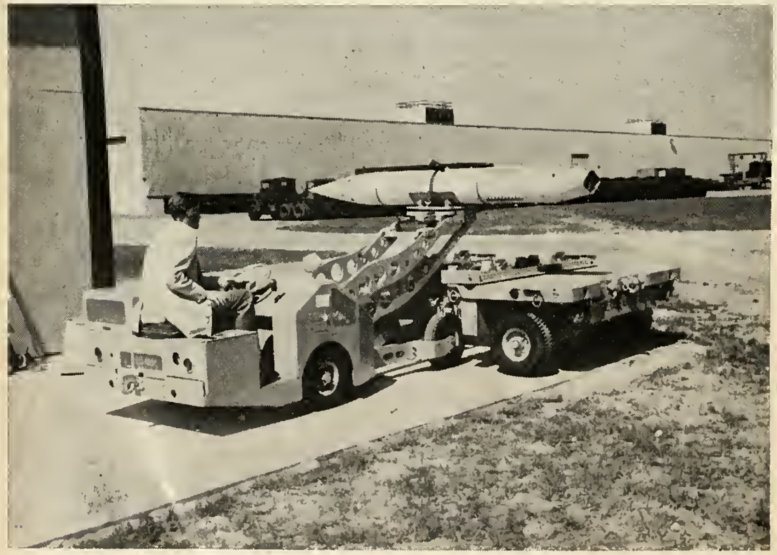
So the question of mobility boils down to first trying to decide how much mobility is required for the missile system to adequately perform its mission. Tactical systems demand mobility; strategic missiles may or may not be mobile, depending on many other factors.

Many feel that the hard base is already obsolete and the soft base—except in the protection afforded by sheer numbers—is a liability.

The limiting factor in big-missile mobility is the expected accuracy of enemy missiles. When accuracies of one-half mile CEP are attained, the day of hard-base survival is past. Fixed bases are desirable from many standpoints—including crew comfort—but the Maginot line has little place in Space Age defense. Mobility definitely has a future.

Even real estate problems enter into the mobility picture. Land available for fixed bases—especially in Europe—is limited. Not only do the farmers not want to relinquish their land but the establishment of bases on foreign soil—and the storing of nuclear warheads, in particular—generate severe problems in international relations. Such problems have already been encountered in England and France, for instance.

The different services have different approaches to the mobility problem, chiefly determined by mission and operating environment. All agree, however, that mobility is a means rather than an end. Mobility costs money and has sufficient inherent problems to make it a luxury if unsupported by actual requirements. And the money and problems are in the support equipment. It is here that much can be done to make equipment simpler, more reliable, and less expensive.


AIR FORCE BULLPUP missiles are loaded on transport.trailer with ubiquitous MJ-1 loader, originally designed for F-105. Cradle adapter provides positioning.

- **Army approach unique**—The Army's approach to mobility is simple: "If it's not mobile, we can't use it." Only one Army system—the *Nike-Zeus*—is not mobile (and some proponents claim that even this, too, should be.) Even the *Jupiter* was designed to be a mobile system.

The Army likes to point to Germany's experience with the World War II *V-2* in support of its philosophy of mobility. No fixed-base *V-2's* ever survived to fire operationally. In contrast, no *V-2* on a mobile launcher was ever destroyed by aircraft—even in the face of something like 30:1 enemy air superiority.

The Army also contends that mobility will be an even more complex problem in nuclear war. Roads, bridges, railroads, and airfields will be knocked out and only "cross-country" mobility will be able to put missiles into firing positions.

Consequently, Army support equipment is built to meet this mobility requirement. It is designed for aircraft and helicopter transport, and for cross-country travel over rough terrain. Equipment must be rugged and reliable, self-contained, and require a minimum of maintenance.

The *Pershing* system is considered by the Army to be today's ultimate in mobility. Missile carrier, launcher, and support equipment are all contained in four tracked vehicles. These can be transported by transport aircraft or the Chinook helicopter. In a very short time after arrival at a launch site the units can be connected and missiles launched. (Actual deployment time is classified; it can be described only as minimum.)

The tracked vehicles used with the *Pershing* are all the standard M-113 armored carrier. Each is adapted for its primary function: missile carrier, nose cone carrier, and other support equipment such as fire control and checkout, maintenance, spares, etc. The *Mauler* system also uses the M-113.

• **Universality?**—The Army has two approaches to "universal" support equipment. The M-113, for instance, represents one approach: use the same basic vehicle wherever possible and adopt it for particular functions. Individual weapons systems, however, require their own direct support and test equipment.

Rear-area (second and third echelon) support and maintenance present a different picture. Army Ordnance has already invested a tremendous amount of time and money aiming for automatic universal test equipment for missile systems (see story p. 49).

One area of support equipment for mobile system that gets little attention—at least publicly—is that of site location. In order to hit a long-range target, the exact location of the launch site must be known. This problem exists for all mobile systems, whether air-, sea-, or land-borne.

The Army considers present techniques adequate and foresees no real problems. Available methods are rather crude, however, and could conceivably stand some refinements. Map grids and survey teams seem rather antiquated in the Missile Age.

The future will probably see the use of small inertial guidance systems for each weapon. This is already a necessity for ship-borne and air-launched weapons and the land-based missile operating in strange territory could well use such a system. Primary requirement is, of course, for small, cheap, expendable guidance units.

• **Ground rules for support equipment**—Army has established a set of ground rules—or "military characteristics"—for mobile support equipment. These set basic configurations such as size and weight, reliability, and operating environment capabilities. The most important are these:

–Operation in combat zone environment (which must include any climate from polar to equatorial and any terrain from ocean beach to mountain top.)

–Mobility to fit the mission.

–Transportability by air or land (with available vehicles.)

–Fast deployment (or reaction time).

–Rugged and reliable with minimum maintenance.

• **Mobility no problem for Navy**—An entirely different aspect of mobility arises in the case of the Navy. At first glance, it appears that all Navy weapons systems are the last word in mobility. Each shipboard system is self-contained, autonomous, and free to move anywhere in the world's oceans.

On the other hand, however, few of the many problems affecting mobility on land are involved in the waterborne system. In effect, you have a fixed base that can move. Handling, power, and test equipment is part of the fixed base and does not itself have to be mobile. This eliminates many of the thorny aspects of mobility facing other services.

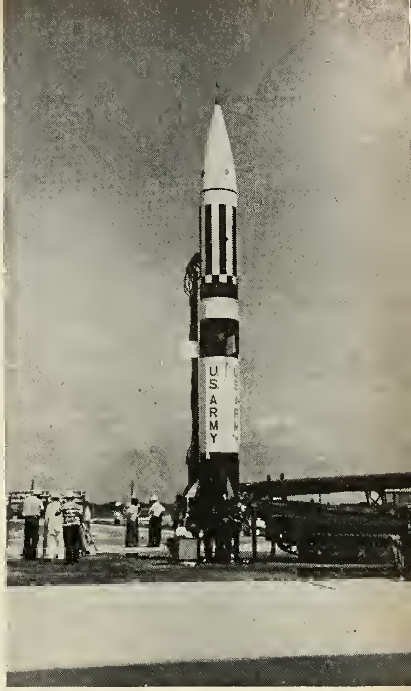
Navy support people feel that they're well on top of most of their problems. New missile ships have automatic handling equipment built into the ship's structure. Once the weapons are loaded aboard the vessel, it's pretty much a "Coke-machine" operation to assemble, check out, load and fire.

Some portable gear is necessary in the case of airborne missiles carried by carrier-based aircraft. These missiles are relatively small, however, and necessary handling is accomplished with modified bomb dollies and skids. Mechanical handling gear has been designed for carrier installation but, due to lack of money, none has yet been built.

Depot and dock-to-ship transport is, in most cases, handled with the ubiquitous fork-lift, adopted for the various weapons.

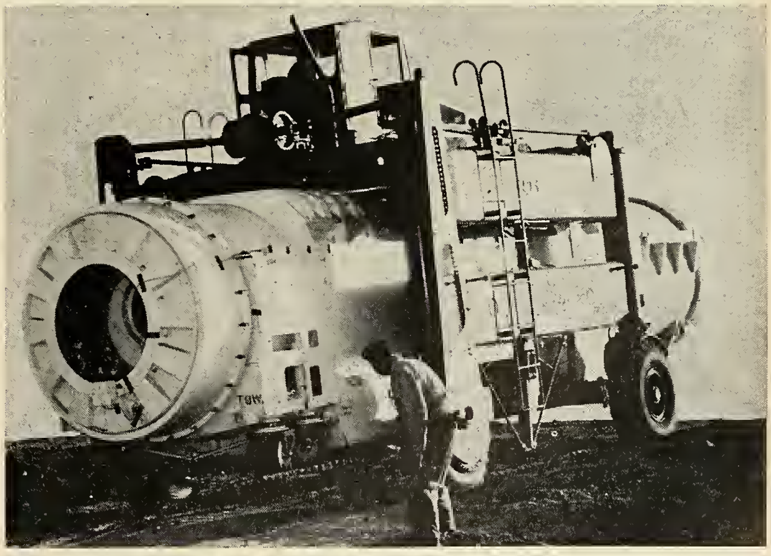
Inter-communications in a ship-borne missile system—for checkout, loading, launching, etc.—is carried by usual shipboard circuits. Such circuits appear capable of meeting requirements and no new systems are contemplated.

Ordinary electronic test equipment carried by ships is sufficient for most maintenance and repair functions. Instruments that require extensive calibration are serviced during periodic yard overhaul periods. Checkout equipment peculiar to the missiles system is installed aboard ship and, in most cases, is operated by the ship's power supply. In spite of the crowded environment and high density of electronic equipment, no serious problems have been encountered with crosstalk or r-f interference.



ARMY's Pershing has combination of TEL (transporter-erector-launcher), M-113.

There remains one major problem in sea-borne missile support, however, and it is giving the Navy considerable concern. This is the requirement for transferring missiles between ships at



STANDARD STRADDLE CARRIER transports Polaris missiles and special containers at Charleston submarine loading base. Carrier is built by Clark Equipment Co.

sea. Navy logistics have long depended on at-sea transfer of supplies. The same requirement holds for missile replenishment.

Conventional methods—using slings supported by a cable running between ships—are much too uncertain and hazardous for transfer of delicate, explosive (and expensive) missiles. New techniques will have to be developed.

Bureau of Ships is working on the problem of installing mechanical handling gear aboard ammunition ships. This is only part of the solution, however. Bridging the overwater gap between ships is the major portion.

Navy spokesmen see no radical departure from present techniques for other aspects of handling and checkout. They foresee little expansion of the "fixed-ammunition" concept—such as *Bullpup* and *Sidewinder,* which require little or no shipboard checkout. The need will continue for test and checkout equipment.

As for mechanical handling equipment, this must be kept as simple and universal as possible. The Navy still has guns. Equipment must be able to handle conventional ammunition as well as missiles. Also, insofar as possible, the same gear must operate both on ship and in the depot.

• **AF has two approaches**—Mobility is looked at by the Air Force as a necessary evil. Fixed bases for strategic missiles are, of course, preferred for many reasons. But when enemy missiles achieve sufficient accuracy fixed bases become untenable.

The Air Force hedges its bets with both fixed and mobile systems. It estimates that the Russians will attain the required ½-mile CEP within five years and base mobility plans on this assumption. Ultimate aim—or "true posture of mobility"—is a manned and maneuverable space weapon.

Free-wheeling Test Device

GYRATIONS OF missile component test boom describe Ferris-wheel pattern at Aeronutronics' Engineering and Research Center, Newport Beach, Calif. The device is used to rotate models in radar studies.

The Air Force has two mobile strategic missile programs in the works at present: *Minuteman* and *Sky Bolt.* The former—both hard-based and train-carried—is scheduled for operational status in mid 1962. *Sky Bolt* should be operational sometime in 1964.

Both systems pose problems in support equipment. Mobility demands sophistication, ruggedness, and reliability—all of which cost money. Harsh and variable environments pose problems, particularly in the case of airborne equipment.

Major problem for *Sky Bolt* is development of equipment to establish the instantaneous launch-site location. Pinpoint accuracy is not required since the ALBM can use a star-tracker to refresh its guidance memory. But establishing even a close approximation of the instantaneous position of a near-sonic launch platform is a difficult job. Terminal guidance capability is the ultimate goal.

Launch-site location for *Minuteman* is a different situation. Previously established benchmarks will provide the necessary information.

Communications—the key to coordination—is a real problem in any mobile weapon system. *Minuteman* will use airborne command posts with single-sideband radio links. This will get away from the possible loss of ground radio stations and towers through enemy attack. Problems remain, however, even with the use of the more sophisticated radio links. Interference, blackouts, and solar and ionospheric disturbances plague critical command communications.

The more mundane areas of mobile missile support—transport and ground handling—generate their share of problems for the Air Force. Difficulties have been encountered with the *Minuteman* train transporter-erector, for instance (see story p. 29).

The big missiles pretty much require custom-designed equipment. Efforts have been made to standardize some ground-handling components for the smaller missiles.

Probably the best example of universal equipment is the MJ-1 low-silhouette lift truck used in numerous missile applications. This unit—with adapters and cradles—performs a variety of jobs including transporter, lift, maintenance platform, and assembly aid. It comprises a large part of the *Bullpup* GSE (see story p. 42).

Whatever the problems generated by mobility, the Air Force feels they can and must be solved. Mobility will become increasingly important, leading to the ultimate of mobile space-borne weapons systems. ⁘

Mobile Minutemen to be 'Randomized'

Air Force plans to have most of its Minuteman trains set up in launch points at any given time; test deployments a big success

those who optimize,
and finalize,
now strategize
that Minuteman should "randomize."

by William E. Howard

DEPLOYMENT OF *MINUTEMAN* ICBMs on the nation's railroads is still more than two years away, yet the Air Force today feels that substantial numbers of these mobile missiles will survive any wartime conditions—and still be able to respond to a Soviet attack.

The solution to the survivability problem does not lie in keeping the missiles constantly on the move, as might be assumed.

Instead, the Air Force plans to have more than 50% of the missiles set up, at all times, at pre-surveyed launch points along railroad sidings. They would be ready to fire on minutes' notice, just like *Minutemen* from hardened silos.

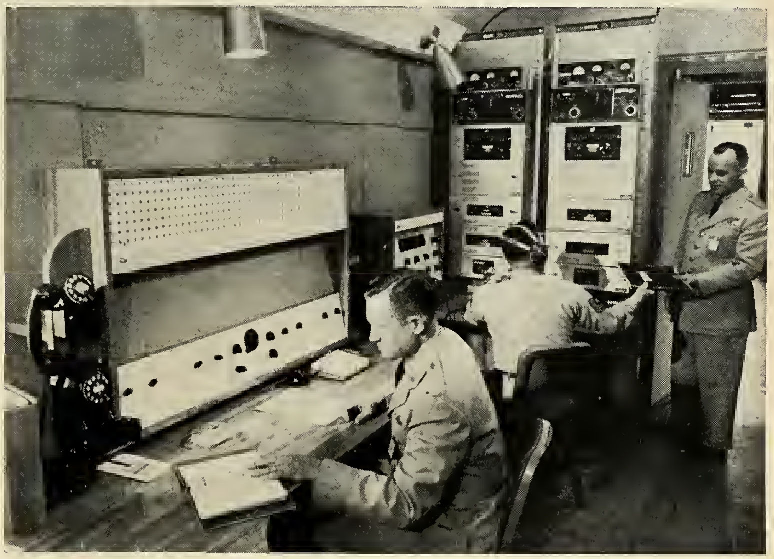
Each train will remain at any one launch site an indefinite period of time. Perhaps only two hours, or maybe 20. The missiles will then be stowed back in their horizontal traveling positions and the train will shuttle off to a new location, which could be 5 miles away or 500. There will be no set pattern.

The Air Force calls this "randomized" deployment, or "programed deception."

Enemy agents might know full well the various areas missile trains are operating in. But, after determining target information of a particular train at a particular site, the agent will have no assurance the train is still there by the time his information reaches Moscow.

"You might say this complicates their intelligence operation just a little," says an Air Force officer drily.

Even assuming the Russians eventually develop a highly effective satellite reconnaissance system, the missile trains not only would be difficult to identify among other trains on the tracks, but their mobility (i.e. more frequent randomization) would make their total destruction by a surprise missile attack extremely difficult, the Air Force believes.



MINUTEMAN MOBILE Command Center, heart of the Minuteman test train "Big Star," including command office and communication station. Boeing installed equipment. Communications systems include powerful "Single Sideband" radio.

Randomized deployment thus is designed to overcome the main critical objection to missile trains; that they are vulnerable because they are exposed, in contrast to a *Polaris* submarine—the nation's first mobile ICBM system—that has the advantage of concealment beneath the sea.

• **100 trains possible**—Much of the Air Force's confidence in a highballing *Minuteman* stems from four deployments of a test train this summer from Hill AFB, near Ogden, Utah. In these 10 to 14-day trials, both communications and operation of the train equipment proved so successful that two additional deployments that had been planned were cancelled by the Strategic Air Command as unnecessary.

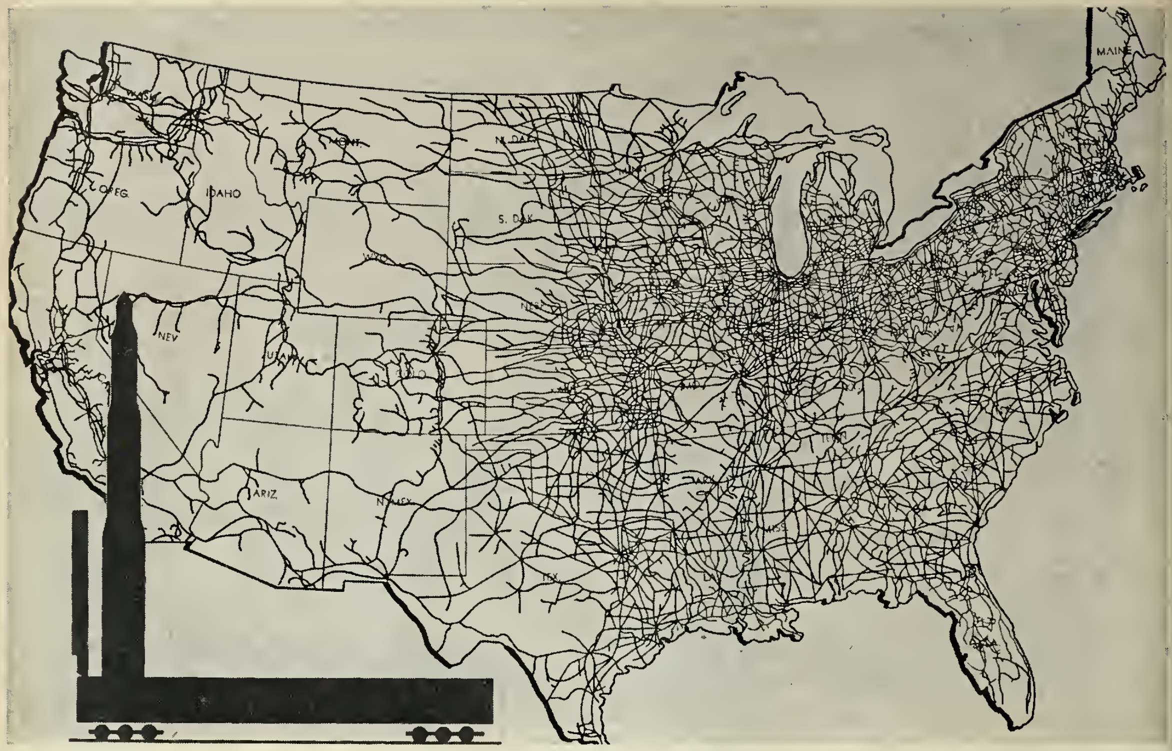
Test data is now being evaluated to determine the composition of trains, number of missiles per train, ancillary equipment etc.

Just how many men will be needed to launch the missiles is still a question. The best estimate is between 25 and 30 for a train of five missiles. More explicit figures are expected to come from some studies currently being run by Boeing Airplane Co., prime for the program.

The maximum number of *Minutemen* expected to be deployed on rails is reported to be about 300. Above this figure, the railroads would become too big a target. Individual trains could carry either three or five missiles, thus requiring from 60 to 100 trains.

Trackage also is a factor. Some studies have shown that a train bearing five missiles should have 900 to 1200 miles of track to operate on for two weeks.

Test trains were made up of about 14 cars—the latter two deployments included the trucks and bed of a pre-



MAP SHOWS all major U.S. rail lines, totaling some 220,000 miles of railroad. About 100,000 miles in Northern half could handle 100 missile trains.

prototype, air-suspended missile car being developed by American Machine & Foundry and ACF Industries. This flat car bore an inert model of a *Minuteman* to simulate the missile's weight.

Boeing furnished a command and control car. It was equipped with single side band and UHF radio for contact with the Train Control Center at Hill AFB and with the SAC Command Post at Offutt AFB, Neb.

Another flat car bore a trailer truck containing an inert third stage *Minuteman* motor made by Hercules Powder Co. to obtain environmental control data.

• **Living cars needed**—Other units, in addition to the diesel locomotive, included four ambulance and two hospital cars which had been converted for use by the 21-man SAC crew and other personnel. There also were two tank cars and a box-car for fuel, water and supplies to make the train self-sustaining for two weeks. In the first deployment, the train carried a pickup truck in the box-car as emergency transport. A jeep later was substituted when the crew found the truck could not be unloaded very easily and it was impossible to drive across tracks in a railroad yard.

The tests revealed that it probably will be necessary to design special living cars for the crewmen. Army ambulance cars will not be available for conversion and the ones used on the tests proved to be rather cramped and to contain waste space (a small kitchen and nurses' station).

One of the hospital cars was used as a ready (recreation) room for off-duty personnel; the other for dining and the kitchen. There was television and radio in the ready room. But, the main diversion at night was outdoor movies shown on a screen rigged on a cattle fence next to a siding.

As much as anything else, the trial deployments were a test of whether missile trains could be handled along with regular traffic on the roads and with union trainmen at the controls.

• **No strike pledge**—Unlike other types of missile deployment, the mobile *Minuteman* will be dependent upon civilians to move the missiles to where they can be launched. The decision to man the trains with regular train crews presumably was prompted by a desire on the part of the Air Force to avoid a battle with unions and to skirt the necessity of training hundreds of airmen in the complexities of train operation.

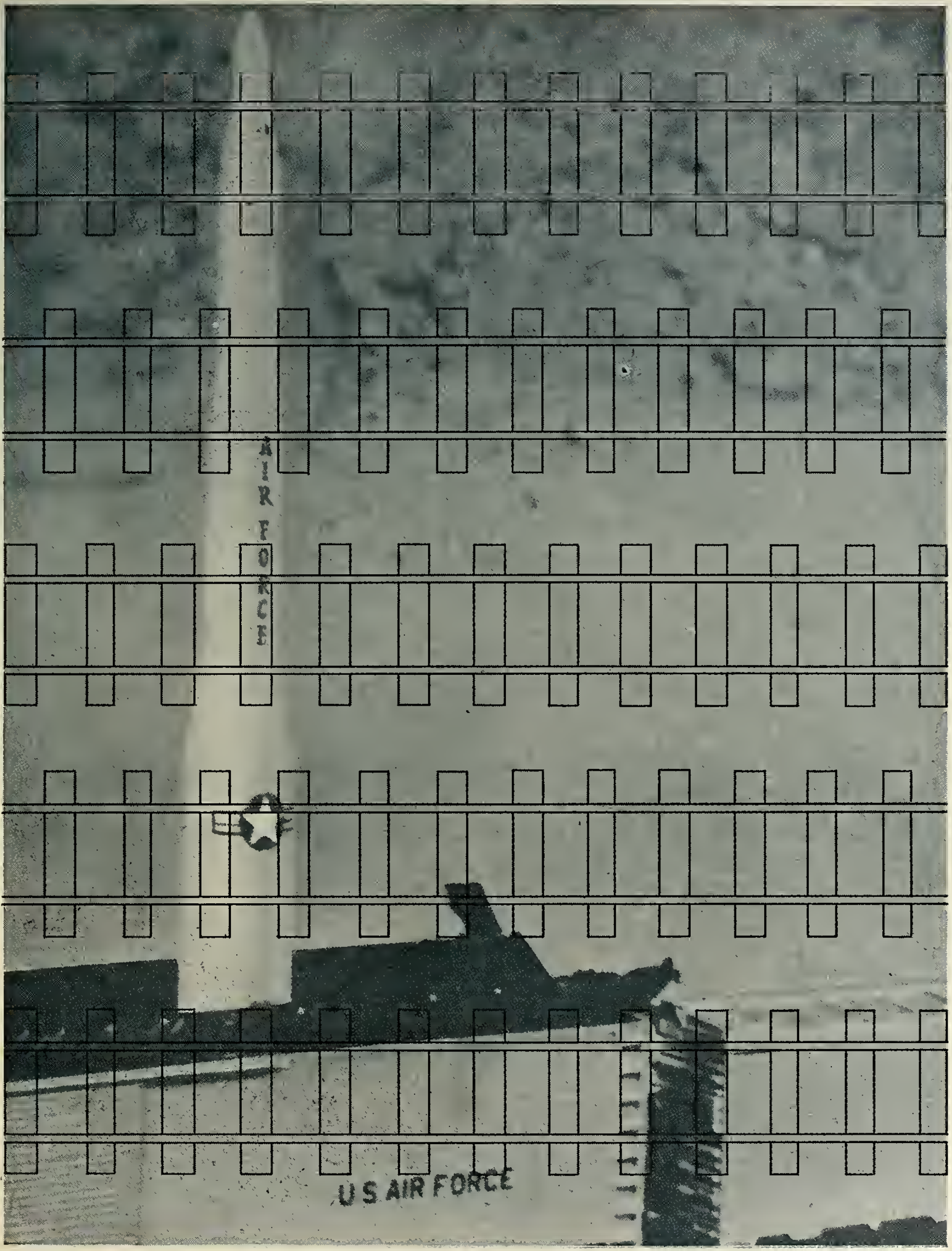
Because of the extra jobs which will be created, the unions have agreed to cooperate fully—within union regulations. To show their support of the program the rail brotherhoods and railroad management through the Association of American Railroads have pledged there will be "no work stoppages" in the maintenance, scheduling, dispatching and operation of missile trains.

Although movement of the test trains went smoothly, there were some eye-openers to the Air Force men aboard. They found, for example, that union rules required a change in operating crews every time they arrived at a division point or switched to another line—even though most division points are less than 150 miles apart.

Operating crews with seniority spurned the bunks in the ambulance cars and slept in their own caboose, which they were allowed to couple on to the missile train under union rules. Presumably they will continue this practice with operational missile trains.

Initial deployments were confined largely to the northwestern states. In the fourth test run, however, the train went as far east as Illinois. Although there are some 220,000 miles of railroad track in the United States, only about 100,000 miles of it is in the northern half of the nation, and within *Minuteman's* striking range of Russia.

However, Canada has another 40,000 miles of railway which conceivably could be made available to the *Minutemen* trains. Thus, there would be sufficient track to deploy 100 trains at 900-1200 miles per train.



24-hour commuter with an intercontinental job. Air Force Minuteman is a solid-fuel ICBM capable of instant action. It can be fired from a fixed base, railroad car or truck to a target 6,000 miles away. Its launching sites will be as flexible and widely dispersed as the country's transportation network can make them. Its important re-entry vehicle, the "business end" of the ICBM, is developed and produced by Avco—also producer of warhead-carrying nose cones for the Titan and Atlas ICBM's.

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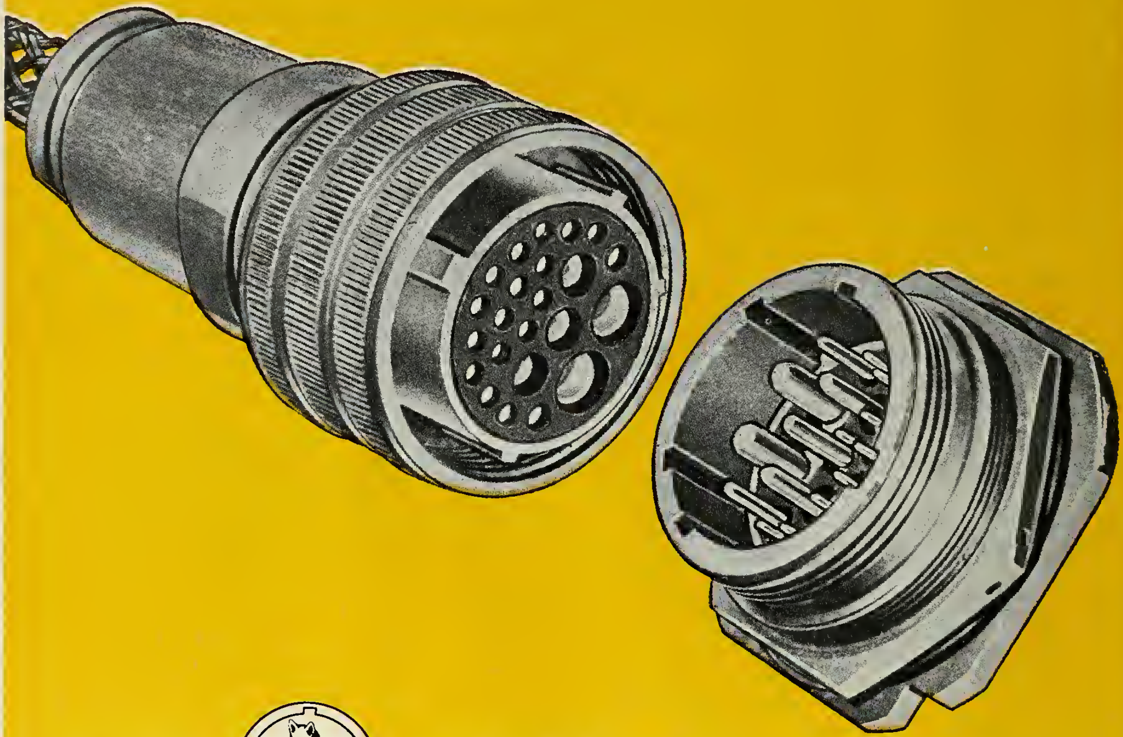

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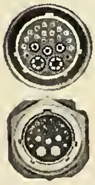

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Cargo Ships as Minuteman Bases?

Typical fleet of laid-up World War II Liberty ships takes up space at Jones Pt., N.Y.

ONE MEANS of meeting the cost challenge to big missile mobility could be to send *Minuteman* to sea in Liberty ships.

The idea of converting some of the 1500 World War II cargo vessels currently rusting away in various lay-up fleets into floating ICBM pads is before the Air Force for consideration. But, so far it has received little support —mainly on grounds of vulnerability.

Although proponents of the idea concede the slow moving, unarmed merchantmen alone would indeed be easy prey to Russian subs, they contend that it is possible to protect them with warships and in certain waters, such as harbors. Moreover, the proponents say that wide dispersal of these moveable launch platforms would more than offset their vulnerability to surface attack by complicating enormously enemy efforts to destroy them before they could fire their missiles.

The major factor in favor of the proposal is that it would be relatively cheap, according to studies originated by planners at American Machine & Foundry. The solid-fueled *Minuteman* —expected to be operational in mid-1962—is about 60 ft. long and could be padded rather easily in the hull of a ship.

• **Potential**—The WWII moth-balled cargo fleet, consisting of vessels of the EC-2 (Liberty), EC-21 (Victory), and the C-1, C-2, C-3, and C-4 types have a load-carrying capacity ranging from 500 to 14,000 tons.

Carrying permanent ballast, these ships would be capable of storing and firing from five to nine *Minuteman* ICBMs, and the total cost would be about 1/100 of that of a *Polaris*-laden submarine.

The surface launching fleet could also carry the *Polaris* IRBM, but *Minuteman* has an advantage in greater range.

Though many engineering details would have to be solved before the cargo-ship missile launcher idea becomes a reality, AMF engineers believe that none would be insurmountable.

Some of these problems, and their possible solutions, are:

–Cooling: The average cargo ship has five holds, each of approximately 300,000 cubic ft. storage. All are equipped with double bottoms, which are presently used for fuel storage.

If these bottoms were sealed air tight, they would serve as excellent insulation barriers against heat generated during launch.

Another possibility would be to flood the cargo holds with sea water, using compressed air as is now used in certain launching techniques.

A combination of shielding materials and sea water cooling could also be used to dissipate the heat before it could cause any damage to adjoining steel structures.

–Sonar Detection: Submarine Warfare—During WWII, cargo vessels were considered clay pigeons by the German U-boats. It could be argued that now, with the even more advanced undersea craft of the Russian Navy, the cargo ships would be even more vunerable.

This argument would be valid if only ten missile ships were put to sea for Russian USW to follow and track individually. But if 400 floating *Minuteman* launchers were commissioned, the Russians could not follow them all, nor could they track them all.

It is further argued by AMF engineers that these low speed (12 to 16 knots), unarmed and otherwise unprotected would make ideal retaliatory weapons because they would be constantly moving, and any one vessel in a period of two hours would be outside the destruction periphery of the highest megaton warheads that might be thrown at them.

• **Surface ships as tactical weapons** —The *Minuteman* launching ship would be free to sail at will the Atlantic, Pacific, Indian, and Arctic Oceans, and could even enter the Mediterranean Sea.

This mobility would allow the surface-ship missile launching fleet to lob their 5000 mile ICBMs at any potential target in the world.

Guidance, according to AMF engineers, offers no particular problem, since there are commercial loran available, and a two-dimensional doppler systems is easily adaptable.

The system recently perfected in the *Polaris* launchings could easily be adapted for launching missiles from surface ships.

• **Cost**—At present the U.S. Maritime Administration is turning WWII cargo ships over to private company operators in first class operating condition for approximately $250,000.

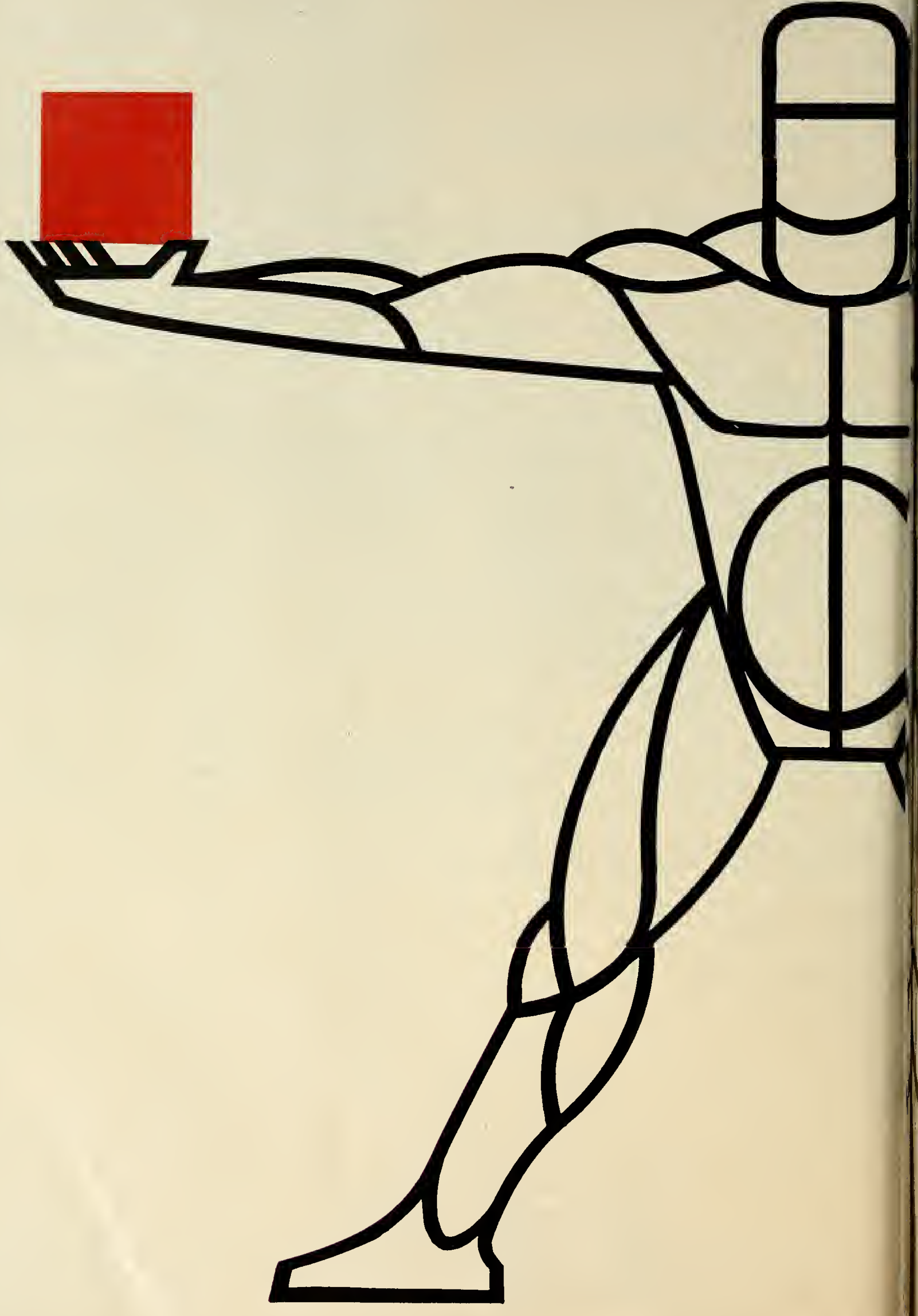
AMF engineers believe the cost of modifying these ships into launching platforms would be comparable to other forms of deployment.

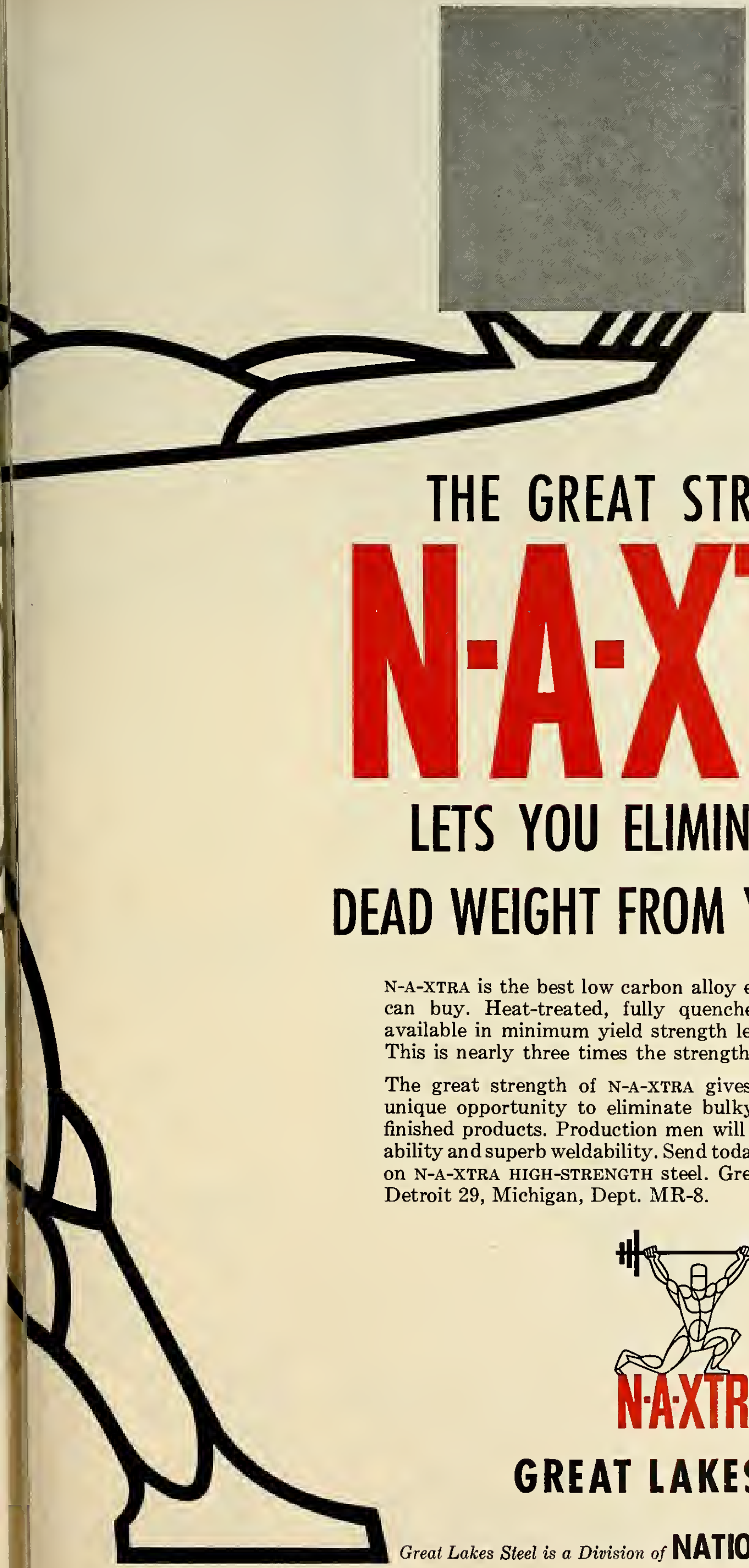
Current estimates of *Minuteman's* cost ranges from $2.4 for a hardened base bird to $4.8 million for each *Minuteman* on a train.

It is conceivable, therefore, that a surface launching ship could be put to sea with nine *Minutemen* for as little as $20 million or as much as $40 million—with most of the money spent for the missiles.

• **Psychological advantages**—Besides the tactical capabilities of the surface-ship missile launchers as part of the U.S. deterrent force, it is suggested that their presence on the open seas and in foreign ports would have tremendous psychological impact.

These vessels, along with the *Polaris* submarines, would give visual evidence of the retaliatory capability of the U.S. armed forces. ⁂





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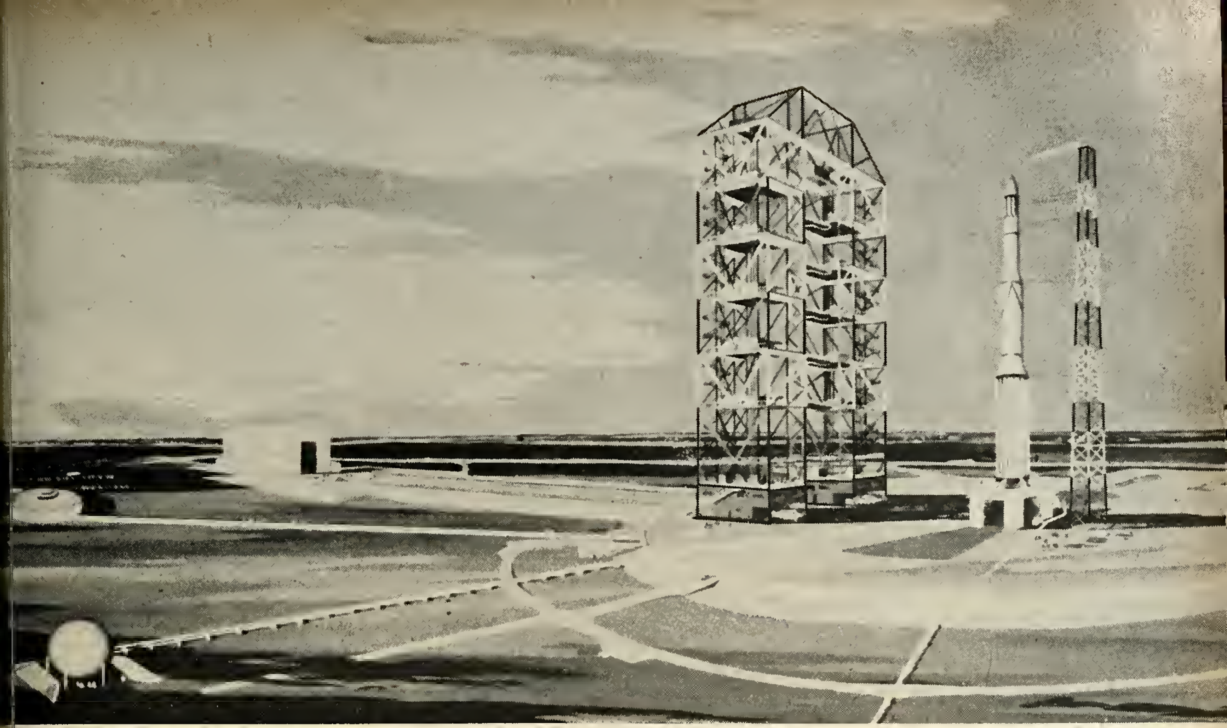


ARTIST'S CONCEPTION of Army Engineers' Saturn service tower, being built for the Cape, which will be 310 ft. tall.

GSE

SPECIAL ISSUE

How Huge Saturn Tower Was Designed

Unprecedented problems were overcome by Kaiser engineers in creating 2800-ton gantry; first step was to divorce major loads

by N. M. Schroeder
Kaiser Steel Corp.
Montebello, Calif.

DESIGN OF THE *Saturn* service structure—310 feet high and weighing 5,600,000 pounds—involved many problems never encountered before in missile gantry construction.

The most critical of these problems centered around putting the gigantic structure on wheels so it could be moved between the launch pad and the safety area. That these puzzles have been solved and construction actually started is a tribute to American engineering ingenuity.

Construction—under a design-build contract with Kaiser Steel Corp.—began last month. Completion is scheduled for early spring, 1961.

Basic performance requirements imposed on the service gantry undercarriage became quite restrictive when the structure's height, its 2800-ton weight, and the elements prevailing at the site were taken into joint consideration. First, it was decided that the structure must withstand winds up to 120 mph while stationary and unguyed. Second, for overall system compatibility, it was necessary that the tower be capable of self-propelled movement at speeds up to 40 fpm against 46-mph winds, with carefully controlled rates of acceleration and deceleration.

- **Divorcing loads**—Investigation of the first basic requirement—that of the stationary tower—revealed that the combined structural dead load and compressive component of the 120-mph wind overturning moment resulted in such a downward force on the leeward columns as to immediately rule out a conventional wheeled undercarriage and support system.

Even had it been feasible from space considerations to concentrate enough rail wheels to support these loads, selection of bearings and other mechanical components with the necessary static capacity and fatigue life was out of the question from an economic point of view.

And it was not practical to design a tie-down system capable of withstanding the enormous uplift forces on the windward columns of the stationary tower and have its points of reaction to the structure coincident with those of the carriages. Under hurricane wind conditions, any great divergence of reaction points for opposing vertical forces on common tower elements would mean severe stress reversals in the base structure of the tower.

Therefore, the first decision was to completely divorce loads inherent to the stationary, or anchored, structure from those of the mobile gantry. This was done by designing into the base of the structure two separate support systems. One system had to be capable of transmitting the high-magnitude compression and tension forces resulting from hurricane wind conditions; the second system would transmit only those compression loads prevailing under the mobile condition.

This second support system then evolved itself through the design phase of the *Saturn* service structure into four 12-wheel carriages.

It was decided that each of these carriages should consist of three rigid 4-wheel truck assemblies. The 36-in. tread diameter wheels would be mounted on standard railroad gauge and roll on parallel track systems 90 feet apart. Distance between carriage centers in the direction of travel was set at 70 feet.

Since the anticipated load on a single 12-wheel carriage under the previously stated criteria for mobility approaches two million pounds, it was essential that this load be absolutely equalized between the three 4-wheel truck assemblies. If equalization were not positive, an overload on some wheels would occur and most assuredly result in component failures.

In addition to maintaining load equalization among the individual trucks of a carriage, it was further necessary to provide for the extreme differential in carriage loadings resulting from wind forces. Under a 46-mph wind diagonal to the direction of tower travel, it was estimated that the windward carriage would be required to support only one-half that of the leeward carriage.

- **Cylinders picked**—To maintain a level-and-plumb attitude of the structure under such severe loading conditions, it was decided that hydraulic cylinders would be much better than a conventional load equalizing system of multiple pivots.

It was this consideration—plus the realization that these same cylinders could also be used as rams in transferring vertical loads from one support system to the other (from tiedown anchors to carriages and back again)—that finalized the basic design and geometry of the hydraulically equalized carriage and traction assemblies.

An equalizer beam will be fixed to the base structure of the tower at each of the four support points and rigidly held in a horizontal attitude. This beam will contain three 15-in.-dia. hydraulic cylinders mounted on 90-in. centers. A socket is machined into the rod end of each cylinder. When extended downward beneath the equalizer beam, the socket mates with the male half of a ball-joint mounted at the center of each 4-wheel truck.

This arrangement permits removal of individual trucks for inspection, maintenance, etc., by simply retracting the pistons into the equalizer beam. The trucks may then be rolled out and replaced with ease.

The three cylinders of one carriage assembly are hydraulically linked together with a 1½-in.-dia. manifold. This ensures equal pressure to each of the cylinders, providing perfect load equalization between the mating three truck assemblies.

- **Jacking up tower**—To transfer the tower load from anchors to carriages, the structure is literally jacked up by using these same equalizing cylinders as rams. Hydraulic fluid is simultaneously metered to all four carriage manifolds at a pre-determined rate and irrespective of pressure.

This is accomplished through the action of servo valves located one on each center truck assembly. The valves are actuated by small synchronous-motor driven cams which, in effect, reference the elevation of the equalizer beams to that of the traction rails. As soon as all anchorage tiedowns are clear—each carriage support point having been raised precisely the same distance at precisely the same rate—the tower is ready to move.

Traction power for the tower is provided by four 100-horsepower motors Automatic controls are contained within the tower to accurately control speeds, and compensate for various wind speeds or direction. Speed setting range is variable from 1½ feet to 40 feet per minute.

With the *Saturn* service structure now in its erection phase, it is the opinion of many (including the author) who have followed this tower through from concept to reality, that we are rapidly approaching a size limit for the missile erector-service gantry as it is known today.

Soon it will become necessary to sacrifice many of the present-day service tower conveniences to keep overall weight down and permit mobility. It may become necessary with larger space systems of the future to divorce from one another the many functions of today's service gantry, and provide for separate structures: one to erect the missile, another to facilitate service and checkout, another to support the propellant loading systems.

One thing remains certain. Whatever schemes are arrived at and designed into the missile ground support systems of the future, the *Saturn* skyscraper-on-wheels, an engineering feat by today's standards, will be eclipsed again and again.

U.S. Missile Bases

Twenty ICBM bases in the United States have been named to date for a total of 28 squadrons of SAC Atlases, Titans *and* Minutemen. *Charleston, S.C., is the loading depot for the* Polaris *fleet.*

One 2-squadron Titan *base is yet to be named, plus bases for at least five more 50-missile* Minuteman *squadrons. A Pacific Coast* Polaris *depot also may be selected in a year or so.*

Ten of the 11 Atlas *bases shown on the map have one squadron. Warren AFB has three. Six of the* Atlas *squadrons will have 12 launchers dispersed in hard silos. Two squadrons have six missiles in soft pads. The remaining squadrons each have nine missiles, some of them in semi-hard pads.*

Titan *bases at Ellsworth, Mountain Home, Larson and Beale each have one 9-missile squadron in hard pads. The others have two. Three 50-*Minuteman *squadrons are at Malmstrom.*

Shaded area in Northwest is where the first Minuteman *train deployments are to be made, starting in early 1963.*

NASA Building at Cape

About $30 million worth of construction for the National Aeronautics and Space Administration at Cape Canaveral has been funded this year.

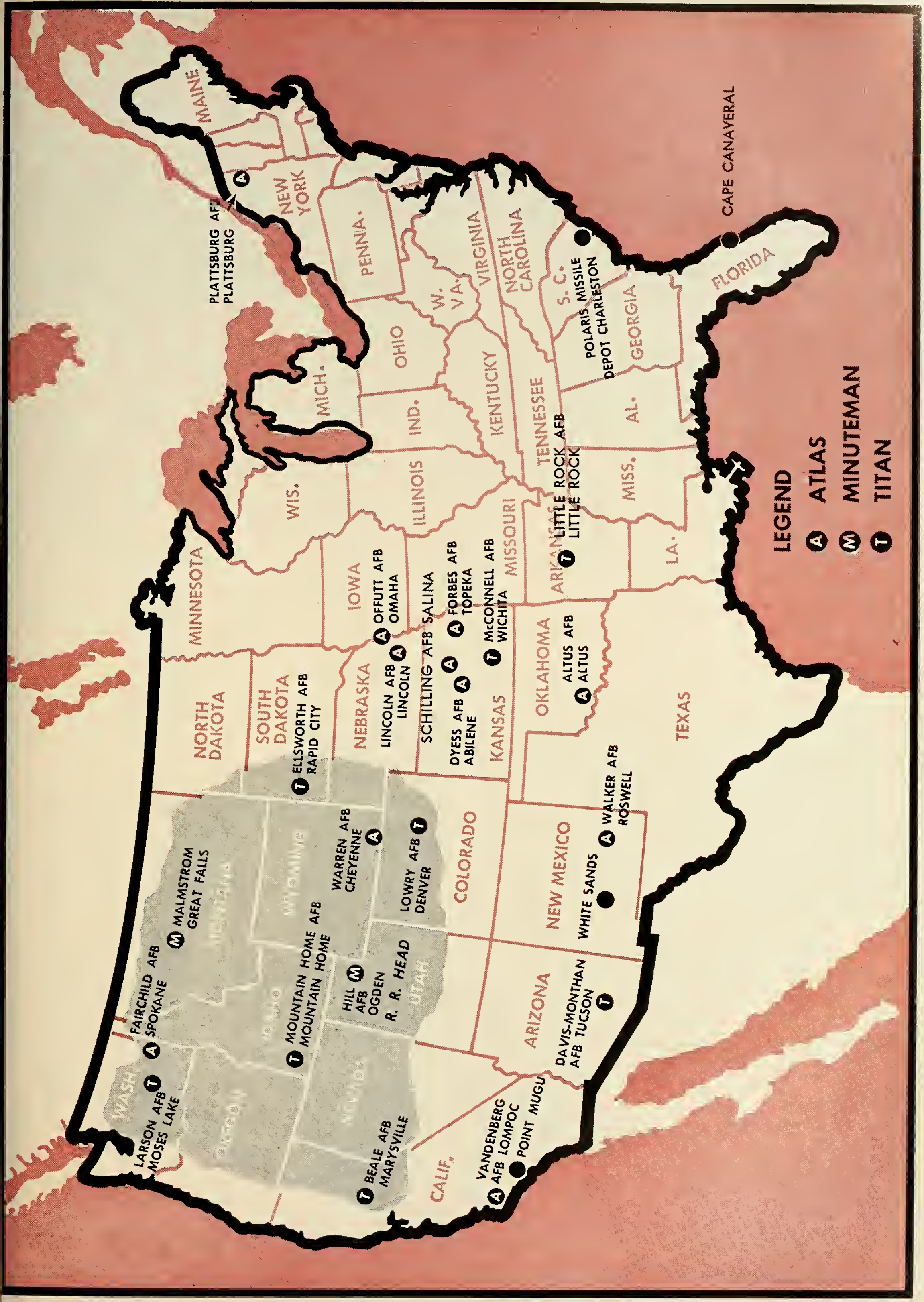
To complete the first *Saturn* launch facility by next year, $2.25 million was appropriated for equipment for the staging building, completion of instrumentation sites, pad and blockhouse communication and electrical equipment, measuring and tracking equipment and design and engineering.

Congress also appropriated $21 million to begin work on an entirely new *Saturn* launch complex, to handle the larger four and five-stage *Saturn* vehicles and enable doubling of the launching rate.

The total cost of the second *Saturn* launch complex is to be about $29 million. The remaining funds will be requested in the F.Y. 1962 budget.

The current funds include $1.675 million for blockhouse construction, $8.15 million for the service structure, about as tall as a 30-story building, $7.675 million for pad and area development, $850,000 for the umbilical tower, $900,000 for fuel and oxygen storage facilities, $250,000 for liquid hydrogen facility design and $1.5 million for ground support equipment.

Other construction includes: modification of an existing stand for *Agena-B*, $4 million; liquid hydrogen system for the first *Saturn* complex, $2.5 million; *Saturn* staging building, $1.25 million; and addition to engineering and laboratory building, $300,000. ⌘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Standardization Cuts Cost of Bullpup Support

Stress on use of existing GSE will make Air Force version of GAM bird relatively inexpensive and provide easy handling

by Joseph P. Smith, Jr.
Wells Industries Corp.
Washington, D.C.

MHU-12 TRANSPORT TRAILER carries four Bullpups at speeds up to 20 mph. Adjustable chocks and available sideboards make the unit a multipurpose vehicle.

COSTS OF SUPPORT equipment for the Air Force version of the Martin *Bullpup* air-to-surface missile (GAM-63) will run far below the average of other AF missile programs.

The savings are due partly to the simplicity and reliability of the system, but primarily to an intensive effort toward maximum utilization of existing GSE and a minimum of new development.

The need for standardization was the first consideration of Martin engineers when they went to work on design of GSE for the AF *Bullpup*. A study of equipment used by the Navy for the original version of the missile showed that it was unsuitable for the new application. According to a Martin report, AF handling requirements posed entirely different problems.

The primary difference in the logistics problem was due to the handling situation aboard ship. Here, all elements are together in one compact installation. Assembly and maintenance areas with fixed equipment, overhead cranes, and elevators are near the flight deck where the missiles are loaded aboard their aircraft. Transportation is a small problem and low-speed skid dollies are sufficient for the short distances involved.

At Air Force installations, storage, assembly, loading, and maintenance facilities may be widely separated. Mobile hoists are necessary. Transport trailers are required that can handle at least four missiles and can be towed at least 20 miles per hour. Equipment maintenance tools have to be moved about to different areas.

Another major item of consideration was that support equipment be air-transportable and interchangeable with and capable of handling conventional as well as special weapons. In additions, the equipment had to be sufficiently flexible to handle the original *Bullpup* as well as the slightly larger AF version to be supplied later in the program.

The first study by Martin produced a tentative list of equipment to meet the requirements. This list was discussed with the Weapons System Project Officer and specialist personnel of the various laboratories involved at Wright-Patterson AFB, and compared against available equipment.

The survey team then carried the logistic plan and equipment list to AF depots, the Eglin Air Test Center, Albuquerque Special Weapons Center, and TAC headquarters at Langley Field.

Out of this came recommendations for use of certain existing units and wo items under development. The esulting list contained four pieces of government-furnished equipment (GFE) and four to be furnished by Martin.

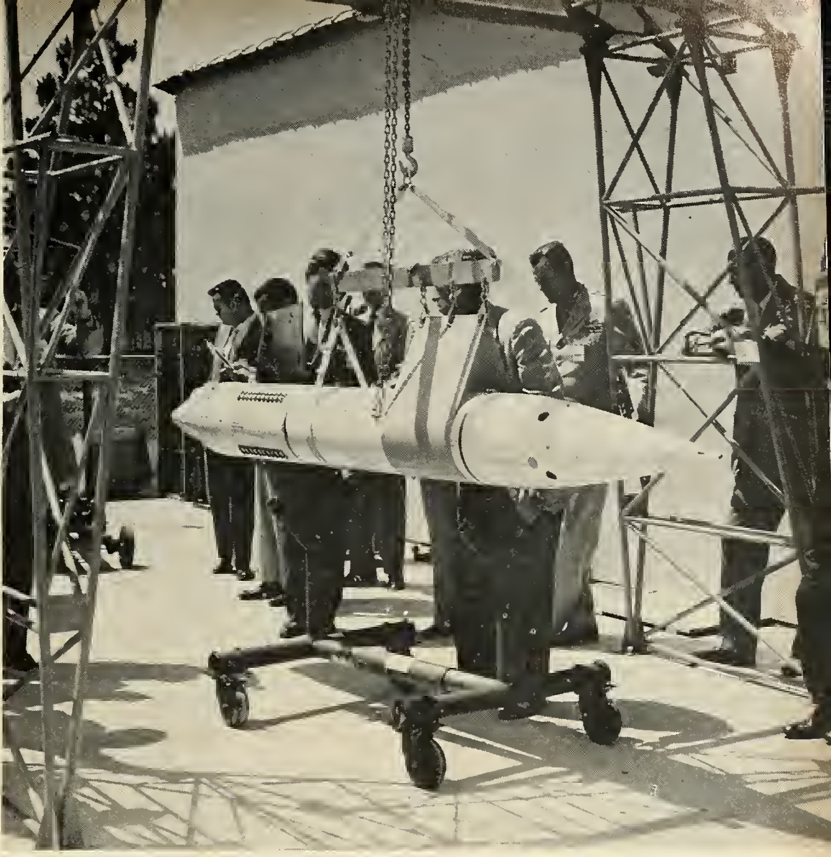
All items of support equipment were brought together in a duplicate TAC maintenance and assembly building at Martin-Orlando. Here missiles were assembled, transported, and loaded n simulation of actual operating conditions. Equipment performed to expectation and later was accepted by the ir Force.

The final approved list of equipment:

ssembly area
H-90 Tripod Stand (GFE) or Airame (GFE)
MHU-12/E Munitions Handling railer or MK-5 Bomb Trailer
MHU-30/E Guided Missile Mainnance Cradle
HLU-40/E Guided Missile Mainnance Sling
MHU-32/E Guided Missile Mainnance Stand
orage area
MJ-1 Aerial Store Lift Truck
MHU-30/E Guided Missile Mainnance Stand
ADU-60/E Lift Truck to Missile lapter (MJ-1 or MHU-31/E Missile) Handling Cradle (forklift)
ight-line area
MJ-1 Aerial Store Lift Truck
ADU-60/E Lift Truck to Missile lapter (MJ-1 or MHU-31/E Missile Handling Cradle (forklift)
MHU-12/E Munitions Handling ailer or MK-5 Bomb Trailer

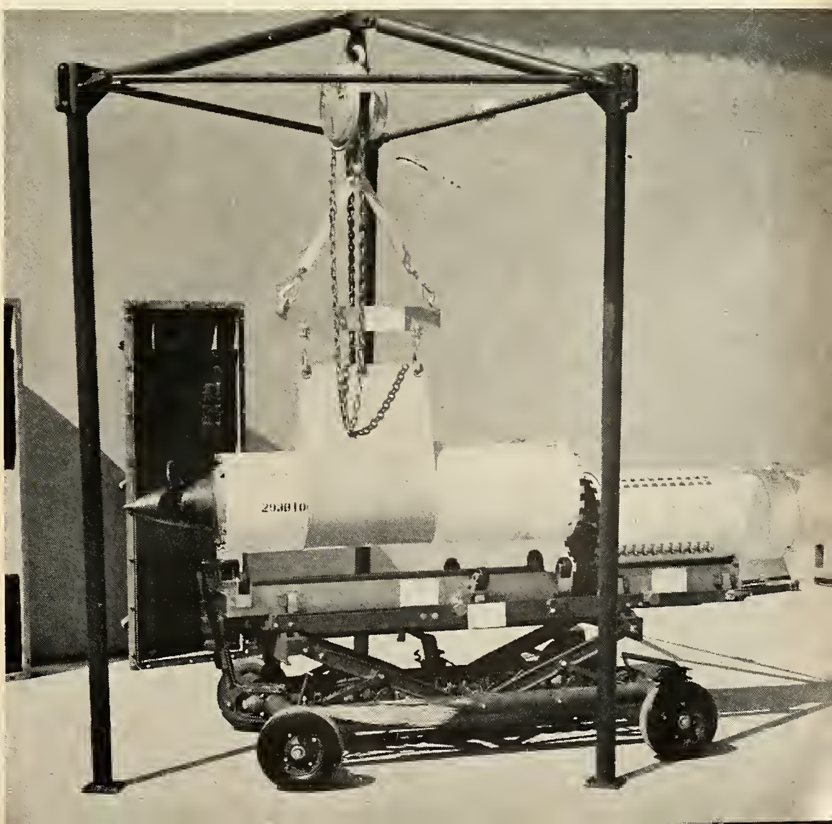
The *Bullpup* missile represents a wing and desirable trend in tactical ssile development. It is used by two vices with little modification. Its en- e is a prepackaged liquid and the embled unit can be handled like a nd of ammunition. The simplicity l low cost of support equipment fit well with the overall concept of the sile system.

The *Bullpup* is expected to go into Air Force missile inventory next r. Only last week, the AF began its ht-testing of two versions of the *lpup* at Eglin AFB, Fla. ⌘



HOISTING SLING used with portable A-frame and adjustable missile storage stand provides flexible, mobile handling gear for storage, assembly, maintenance.

BULLPUPS ARE ASSEMBLED on H-12 trailer with aid of tripod stand and hoisting sling. Aft- and center-section cradle adapters provide proper mating alignment.

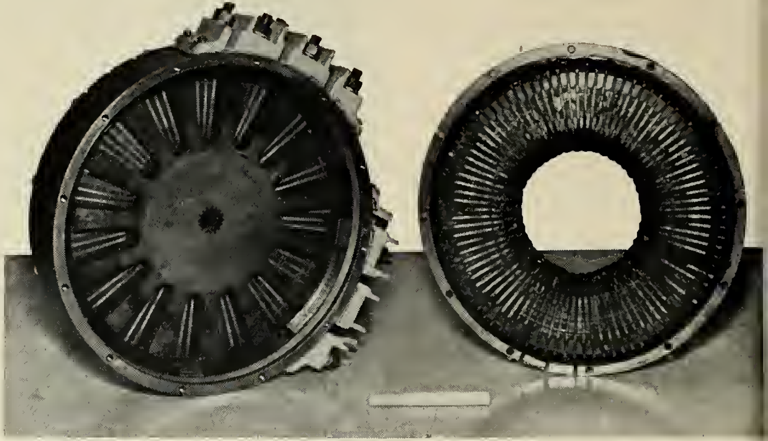


Versatile Gas Turbines: Lightweight Power

Major breakthroughs seen as device makes a bid to become prime mover in Missile/Space GSE Market

W. W. West and C. R. Phaneuf

Both authors are members of the application engineering staff of General Electric Co. at Waynesboro, Va. West is with the Specialty Control Department, Phaneuf with Aviation Electrical Systems Engineering.



SPLIT-STATOR HOMOPOLAR INDUCTOR generator used in VSCF development design has 20 kva output. Stator (at right) is folded around rotor, forming pancake.

THE GAS TURBINE can be expected soon to become an important factor in the ground power market. According to manufacturers' reports, major breakthroughs now imminent will better fit the turbine for many more applications in the missile/space support field.

These improvements, coupled with the new concept of variable-speed constant-frequency (VSCF) electrical power generation, make the prospect attractive for many reasons.

The idea of gas turbines as a prime mover in missile/space ground support systems is not new. They have already been used in a limited number of applications where size, weight, and reliability are of prime importance. But general application of gas turbines for supplying electrical power—although talked about—has yet to become a reality.

The reason behind this is that there are certain inherent problems in the turbines themselves: high-speed operation, specific rate of fuel consumption, etc. However, gas turbine manufacturers have made rapid advances to overcome these apparent drawbacks.

• **Small, light, simple**—One of the basic reasons for considering gas turbines is a matter of logistics. Turbines deliver a lot of horsepower from a small package. In hardened applications, manufacturers report that turbines would require 1/10 the floor area and 1/30 the volume of most of the present prime movers of comparable power. In portable applications, they are almost without peer, since they require less space, and fewer personnel, and can be air-dropped. The gas turbine is 1/10 the weight of most other high-speed prime movers and 1/20 that of low-speed.

But size and weight are just part of the story. Ease of maintenance is another. With a minimum of moving parts—mainly, a rotor—turbines offer a drastic reduction in maintenance costs. One manufacturer points out that conventional systems require a down time of 12 hours per month, plus the overhead of attendant personnel. Turbines are offered with a monthly down time of one hour and are extremely practical for unattended operations.

Turbines offer many other features of interest to support power applications. They use many different fuel efficiently. They are air-cooled an cold-starting; they can run continuousl at rated output, and run at low-loa with no deterioration. They are les affected by environment and highl shock-resistant to air drop or near-mis (one manufacturer will offer a 25- rating).

For hardened sites, the turbine requires a minimum of foundation, need no isolation for vibration, and at th same time offers improved overall thermal efficiency when exhaust heat is utilized for auxiliary services.

As gas turbines near the momen when more general application will n longer be a question but a point in fact the final step needed to bridge the ga emerges in the form of VSCF.

• **Speed solution**—One of the mai limiting characteristics for electric power generation of the gas turbine i its extremely high speed. A gear box i required to reduce the generator spee Moreover, the generator size is quit large and heavy.

Not only does VSCF relieve thes factors, it achieves such a high degre of versatility that the gas turbine ca now become superior in areas neve

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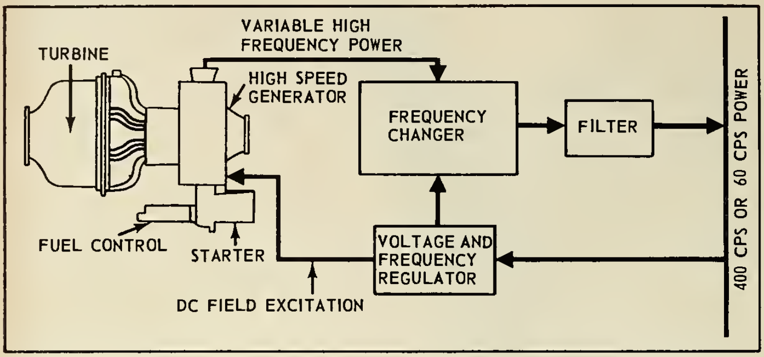
VSCF bridges the gap . . .



BLOCK DIAGRAM of variable-speed constant-frequency electrical power generator.

thought possible. It is at this point that the tremendous potential of the gas turbine in certain ground power applications becomes apparent.

VSCF is an electric generating system which comprises a high-speed, high-frequency generator and a static frequency changer. The generator is integrated with the turbine and supplies variable high-frequency power to a static frequency changer. The output is fed to the constant-frequency bus through a filter. A static regulator maintains voltage and frequency within a wide range of desired limits.

The a-c generator is an advanced design which offers many advantages over conventional machines. To take full advantage of the high-speed turbine operation, a generator capable of being directly connected to the turbine shaft, and operated at high turbine speeds, is required. The inductor type generator provides this capability. Its solid-rotor configuration is simple and reliable. There are no rotating windings to cause unbalance or maintenance problems. The machine contains no other rotating components, such as rectifiers or commutators. It has no brushes or sliding contacts.

The output of the variable-frequency generator is fed into the static frequency changer, composed basically of a power-conversion section and a modulator. The power-conversion elements are silicon-controlled rectifiers, solid-state equivalents of the Thyratron tube. By properly programing the firing of these semiconductors by the modulator, the lower, constant output frequency can be fabricated from the high-frequency input waves.

Output frequency is maintained by the regulator to very precise limits. Accuracies up to 0.001% are obtainable.

Since the system is unaffected by large changes in speed (up to 2:1). transient frequency response approaches steady-state conditions. Individual phase voltage regulation can provide close regulation even under conditions of extreme unbalanced loadings. Provisions for real and reactive load division may be included for parallel operation of several turbine sets.

• **Advantages**—In summary, the improvements for gas turbine operation offered by VSCF are these:

–A small, lightweight generator for direct connection to the turbine shaft. Conventional 60 cps generators at 1200 rpm weigh 10-20 lbs. per kva. Depending on specific application requirements, the overall system can be expected to weigh as little as one-fifth that of other types of ground power, or even less.

–Simpler speed controls are required. In addition, no speed-reducing gear box is needed.

–Improved electrical performance is available from a VSCF-equipped turbine. Frequency transients under load changes do not exist. Close voltage regulation can be provided even under large loading unbalance; damaging output voltage transients are virtually eliminated. With a small (5-15%) increase in system weight, voltage transients for normal load changes can also be a thing of the past.

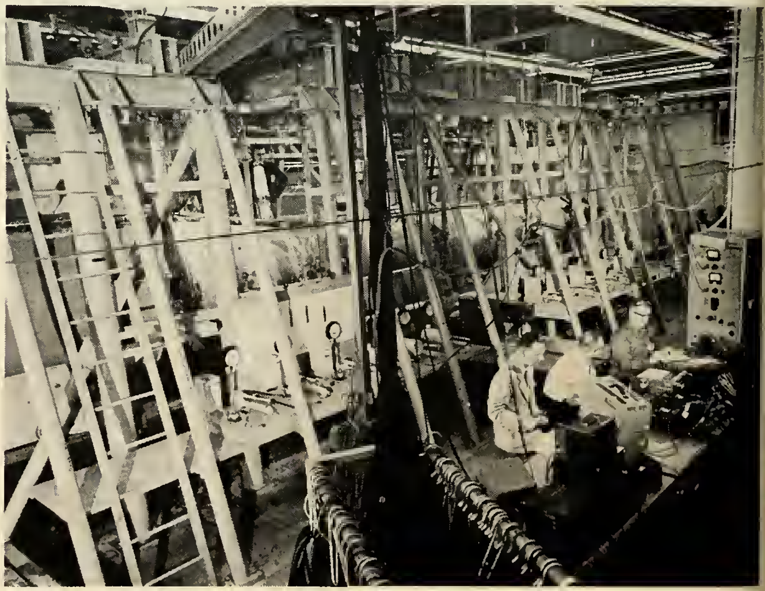
–Versatility of operation is achieved by providing multiple frequency outputs from the same equipment. Either 400 cps, 60 cps, or direct current may be obtained.

–Use of the VSCF system as the turbine starter may eliminate the necessity for auxiliary starting equipment.

–When necessary, the static control equipment can be remotely located from the turbine generator.

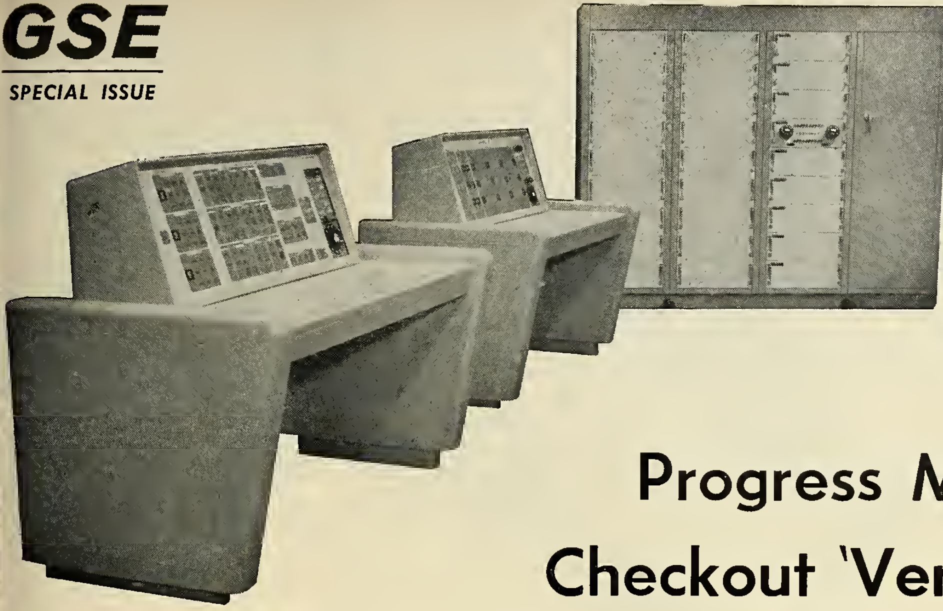
The industry goal of lightweight, compact, portable ground power units is rapidly being achieved. This new concept of static frequency power conversion, with its added features of high performance and extreme reliability is an important step towards this goal.

At present, turbine manufacturers are working to extend the application of such turbine-generator combinations to areas of ground power not formerly feasible. With VSCF, the ground power market will see an ever increasing influx of gas turbines as a prime mover for support electrical systems. ⁑



Simulated Flight Test of Minuteman

MINUTEMAN ICBM undergoes dynamic testing at Boeing's Aero-Space Div., Seattle. Tests simulate seven different flight conditions. Program, nearly complete, will determine adequacy of structural design and aid development of flight controls.



TITAN launch, test and checkout equipment is latest approach to short reaction time requirement.

Progress Made In Checkout 'Versatility'

by W. O. Campbell
Martin-Baltimore

WITH SO CLOSE a tie between today's missiles and checkout equipment requirements, a strong tendency has developed—and is steadily growing for checkout and countdown equipment to become increasingly specialized and complex.

The specialization has resulted in equipment which is not too useful for follow-on programs. Warehouses are full of such equipment; surplus sales abound with it.

The complexity has resulted in increasingly high costs; today one finds that as much as 75% of missile program dollars are spent for ground support equipment.

The specialization and complexity tendencies have interacted to produce equipment which usually is neither available on schedule nor reliable after it is available.

These are the prices now being paid. These problems are so severe that it is imperative that solutions be found. The effort to find answers has already caused certain developments.

First, the military has underwritten programs for the sole purpose of developing checkout equipment which meets some of the more common requirements of most missiles, yet is somewhat independent of any particular set of missile requirements, thus being "universal"—or, as the more conservative elements says, "versatile."

This has occurred during the last three years.

At the same time, industry has also produced versatile equipment, so that today there are several such sets now available in varying degrees of versatility.

• **Confusing terms**—Claims as to the true versatility of these sets vary. Some figures run as high as 75 to 90%; others are stated to be 25%. The picture is somewhat beclouded by the fact that there are as many definitions of the term "versatility" as there are GSE engineers, and that no formal evaluation of these sets against the same group of weapon system requirements has ever been made. Further contributing to the problem is the tendency to use the two concepts "versatility" and "follow-on utility" interchangeably.

There is a distinct difference. Versatility refers to the capability in a given set of checkout equipment for easily accommodating the changes that occur in the test requirements for the airborne article. Follow-on-utility refers to the number of racks that can be used without modification on succeeding programs. The more conservative groups usually quote 25% versatility—meaning follow-on utility—a very practical figure such as a weapon system prime contractor might employ.

Certainly this whole development is a step in the right direction, much better than no development at all. The inherent versatility—be it 25% or 75%—allows a continuous program of development, use, redevelopment, use, improvement, use, until gradually the versatility will be adequate, the cost low, and the reliability high. Such a concept of continual improvement of a basic idea is identical to the techniques used by industry to obtain acceptable reliability, cost, and versatility in almost any commercial product one cares to name.

• **Other progress**—Another development is Project SETE at New York University, authorized by DOD some four years ago to collect and disseminate information concerning support equipment of all kinds from the three services. The yearly symposia hosted through this group are well known to all support equipment designers.

A third is MIL Handbook 300 (USAF), a compilation of support equipment in catalog form. First issued in 1959, this Handbook bids fair to become the Sears Roebuck catalog of GSE. It tells many people what is available, thus serving to minimize duplication.

It is interesting to note that some weapon systems contractors, including Martin, have already taken steps to produce a similar Handbook purely for company internal use, to handle the large volume of support equipment information and designs available within the company.

A fourth development is the appearance within the last two years of many support equipment articles in magazines and at conventions. While the subject content of "message" varies, most of them touch sooner or later on the natural causes which have led to this development—namely cost, reliability and versatility.

All of these developments are essentially particular solutions to the general problems previously discussed.

• **How it works with Titan**—A good example of the new look in missile support equipment is in the *Titan* program

THOR
MACE
TITAN
HAWK
ATLAS
SNARK
NIKE B
BOMARC
NIKE ZEUS
SPARROW I
SPARROW II
SPARROW III
NIKE HERCULES
SIDEWINDER
REGULUS II
VANGUARD
REDSTONE
JUPITER C
PERSHING
BULL PUP
MERCURY
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N/D Designs Assembly Savings Into Critical Miniature/Instrument Ball Bearings!

Helping customers *simplify* instrument assembly is a specialty of the N/D engineering group. How? Through *creative* Miniature/Instrument ball bearing application and design. Often, a new ball bearing design will produce assembly savings in excess of its additional costs. Integral ball bearings, too, very often cut down difficult and costly hand assembly of shaft and parts.

A timely example of N/D customer assembly savings can be seen in Nike Ajax and Hercules missile ground support. Here, *special* N/D Instrument ball bearings are now used in precision potentiometers. New Departure engineers recommended eliminating two *single row* instrument bearings, mounted in duplex and requiring precision spacer and separate guide roller. They replaced this assembly with a *special* N/D *double row* high precision instrument ball bearing with integral outer race guide roller . . . and shaft mounted with a nut. This one recommendation produced cost savings of over 400%! In turn, the customer was able to reduce the potentiometer selling price to the government. What's more, the New Departure Instrument Ball Bearings improved potentiometer reliability!

You can look to minimum assembly costs and unsurpassed *reliability*. Include an N/D Miniature/Instrument Bearing Specialist in your early design level discussions. For immediate information or assistance, call or write Department L.S., New Departure Division, General Motors Corporation, Bristol, Connecticut.

NEW DEPARTURE

MINIATURE & INSTRUMENT BALL BEARINGS

proved reliability you can build around

Circle No. 18 on Subscriber Service Card.

(M/R, September 5, 1960).

This missile is housed in a fixed hard-base installation. It must be capable of being reliably fired upon short notice. Accordingly, the checkout and countdown equipment is designed in a ruggedized rack and chassis manner suitable for permanent installation in the hard base. It is capable of withstanding severe shocks, as is the missile.

Because of the short reaction time requirement, the countdown sequence has been pared to those bare essentials usually referred to as "operations", with almost no testing, as such, in the countdown. The *Titan* requirement for verified reliability has been met by making program and technical provisions for a routine checkout on a scheduled basis, thus again dictating in large measure the test requirements of the checkout and countdown equipment.

This co-relationship between missile requirements and support equipment requirements is just as evident in the highly mobile missiles—*Lacrosse* and *Pershing,* for example. In these, the countdown equipment is transported either on the launcher or on vehicles just as mobile as the launcher, so that all parts of the weapon system are equally mobile. Again, with reaction time of both missiles being rather short, the number of operations in the countdown gear have been cut to the irreducible minimum, several magnitudes less than those encountered in a typical R&D situation.

The reliability of these weapons dictates that the performance reliability of the countdown equipments be very high. It is secured by utilizing certain checkout design criteria developed specifically to meet the performance reliability requirement.

• **Outlook**—Man, being the inquisitive creature that he is, has always enjoyed looking ahead to postulate what will happen in various areas. The test and checkout area is no exception. What will happen?

Certainly the present developments will continue for some years to come, because each of them supplies part of the answer to the total problem. Technical advances such as better comparators, analog-digital convertors, and timer-counters will increase at an accelerated pace, since more and more R&D money will be spent in support equipment developments.

The development of digital versatile checkout sets will continue, because versatility requirements will exist for a long time to come. A curious offshoot of this is that, in the future, certain weapon systems will have design criteria imposed on them to make them easier to test.

The digital computer will also see some use for test and checkout purposes. Mostly this use will center around the indigenous capability—a term meaning that if a digital computer is already on board for other reasons, some of the test and checkout job will be assigned to it.

Another task for large digital computers is the computation of quantities derived from go/no-go checkout results. These derived quantities include such things as statistical measure of weapon performance, flyability index, and weapon system degradation. The go/no-go data will be obtained in much the same manner as it is now, with the results fed over a data link to a digital computer miles away. The computer itself will be specially equipped to handle an equation involving up to 200 simultaneously varying parameters.

Electronic checkout equipment has changed a lot since the beginning of the Missile Age 15 years ago. The equipment in 1945 was a hastily-assembled collection of portable meters and scopes, regardless of the type of missile. Today's checkout and support equipment requirements are much more closely linked to those of the missile; if mobility, basing, reaction, reliability and other requirements of the missile are known, test requirements of checkout and countdown equipment can be readily inferred, if not deduced. ⌘

GSE

SPECIAL ISSUE

Universal Test Systems on the Way

Army Ordnance is reviewing equipment developed by RCA and Nortronics; studies show facilities are practical; first delivery will come 18-24 months after funding

A $6-7 MILLION study program under way since 1955 by Army Ordnance and industry has shown that a universal automatic test facility is both feasible and practical. Prototype hardware for the facility has been built and demonstrated; one equipment contract has been let and others are anticipated "sometime in the future."

The program started with a contract to RCA for research in the field of miniaturization and micro-modules and applicability to field maintenance equipment. Work was later expanded to include multipurpose test equipment. Here began the first look at the feasibility of universal—or, more properly, "multipurpose"—equipment.

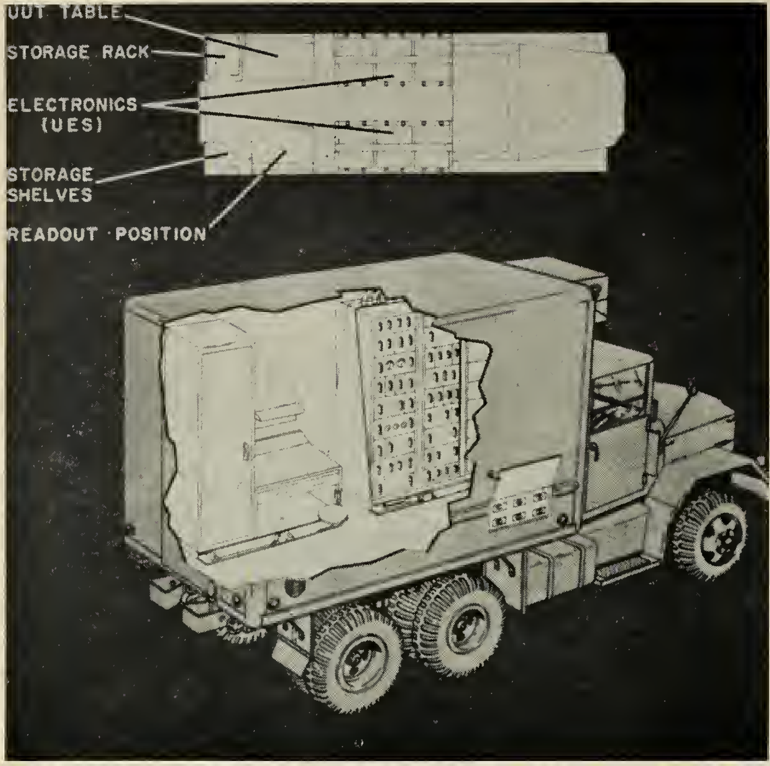
In 1958, Ordnance granted a contract to Nortronics for a feasibility study aimed at a multipurpose checkout system for depot maintenance of the *Nike*. Work was continued for development of a prototype system for evaluation. The Nortronics approach was to incorporate elements of its Datico and other commercial equipment in a system for the automatic checkout of six missile systems.

Concurrently, RCA was continuing work based on its earlier study aimed at developing a similar universal test equipment.

At present, both the RCA and Nortronics systems are being reviewed by Ordnance. Further R&D—scheduled but not entirely funded—will be aimed at producing mobile automatic equipment for field and depot (third-, fourth-, and fifth-echelon) maintenance. After the money becomes available, 18-24 months will be required for first delivery.

Signal Corps has awarded RCA a contract to build a similar system for electronic equipment maintenance for its Tobyhanna, Pa., depot.

• **Characteristics set**—After determining feasibility, the Army Rocket and Guided Missile Agency puts together a specification which sets forth the "military characteristics" of such a system. This MC spells out the necessary requirements, operational and special characteristics and a suggested approach



DIGITAL EVALUATION equipment (electronic unit of shop set) in 2½-ton truck. Complete universal field maintenance system would have 4 vans. (RCA photo)

to the program.

The need for automatic universal test equipment was predicated on several conclusions reached by ARGMA:

–Present concept of providing peculiar test equipment with each missile system is a financial, personnel and logistic burden.

–Over 85% of the basic functions of these peculiar test systems are duplicated in each case.

–Current field maintenance tools and test equipment are designed primarily for lab and production-line use and are not suitable for the field.

–Automatic operation is desirable not only for its speed but because it removes the inherent human factor errors.

The Army also concluded that a universal system could be applied even more efficiently to future missiles. These could be designed with common or assigned power, frequencies, etc., which would fit in with already established characteristics of the test equipment.

Officially termed "guided missile field maintenance shop set," the maintenance facility will consist of electronic, mechanical and emergency repair units. It will be self-sustaining and capable of test and isolation of malfunctions down, where practical, to individual piece parts. Repairs beyond the capability of the electronic and mechanical units would be accomplished by the supplementary emergency repair unit.

• **Operational characteristics**—Design of the shop set will incorporate accepted principles of human engineering for simple operation and minimization of human error. Test equipment will be capable of performing self-test and visually indicating the malfunction down to the smallest component practical. It will automatically provide typewritten information as to location and nature of malfunction and logistic data—nomenclature, part number, etc.—for replacement. It will be able to check out complete missiles, performing both plug-in go/no-go tests as well as component and circuit malfunction isolation.

Mobility requirements are a large factor in the shop set design. All tools and test equipment must be capable of being mounted in standard Ordnance 2½-ton trucks. Equipment must be sufficiently rugged to withstand transport over unimproved roads at 25 mph and over cross-country terrain at 10 mph. It shall be immediately operable after movement without calibration or extensive maintenance. Safeguards will be incorporated to prevent serious malfunctions due to improper hookups, switching arrangements, or power inputs.

Loaded shop set trucks will be transportable by air and have certain amphibious transport capability. Equipment will be air-conditioned to operate in —60 to +125°F ambient temperatures, and be capable of long-term storage with minimum preservation or special packaging.

First priority will be assigned to the development of electronic test equipment. Mechanical, hydraulic, and pneumatic test equipment will get second priority.

The first step in the Army approach to the program is to gather data relating to the maintenance allocation of each system and catalog units expected to need repair. Then technical characteristics of each unit to be tested—power, frequency, terminations, wave shapes, etc.—will be determined.

A further step will be to determine areas of similarity among components common to most missile systems. Applicable existing equipment will be selected and development scheduled for original equipment needed to complete the system.

Accomplishment of the plan requires only time and money. It is generally agreed that the multipurpose equipment would save a great deal of money and greatly ease the logistic burden imposed by present methods of field maintenance. R&D funds are extremely tight, however, and Ordnance is not too optimistic over chances of immediate development funding. ⌘

Mars Travelers Could Ride in Booster Fuel Tank

The first men to land on Mars may make the trip inside a fuel tank.

According to scientists at Lockheed Missile and Space Division, the entire payload, including the earth re-entry vehicle, would be carried within huge chemical booster tanks.

Two of the boosters would be fired into earth orbit, refueled and accelerated to Mars flight velocity—36,000 mph. Then the two rockets would be joined with a half-mile-long steel cable.

Rotation around a common center would provide the crew with essential artificial gravity. The cable would allow a long axis of rotation, sufficient to reduce the effects of coriolis force. If a short axis of rotation were used, the coriolis force would cause a human to reach to the side of an object rather then directly at it.

Lockheed's R. Gillespie says the "cocoon" approach is cheaper and simpler than other Mars flight proposals.

Long-Range Polaris Gets More Funds

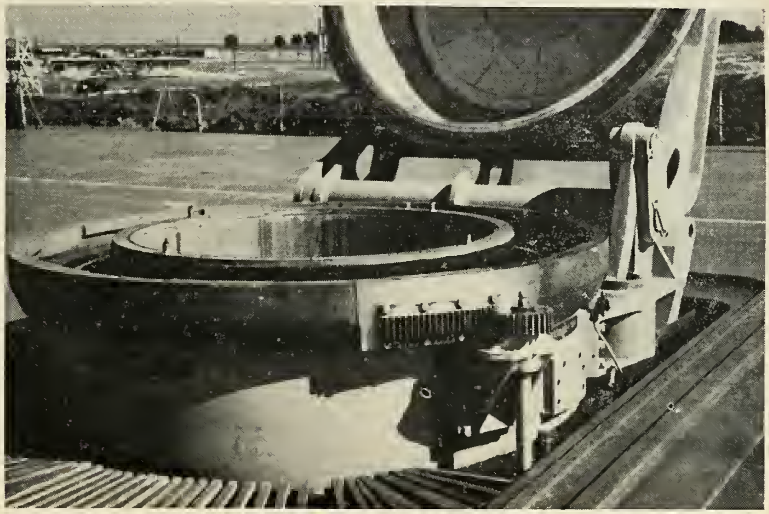
The need for ground support equipment in the *Polaris* R&D program is expected to continue through 1964 with development of the 2500-mile-range *Polaris*.

The Administration has announced that it will release an extra $70 million this year for the long-range program.

Both the 1500-mile and the 2500-mile *Polaris* will be several feet longer than the present 1200-mile version. Launching tubes will be lengthened to accommodate them.

GSE to date has included a vast array of items, from underwater cameras and hydrophones to the very huge ship motion simulator at Cape Canaveral and the underwater launching complex off San Clemente Island, Calif.

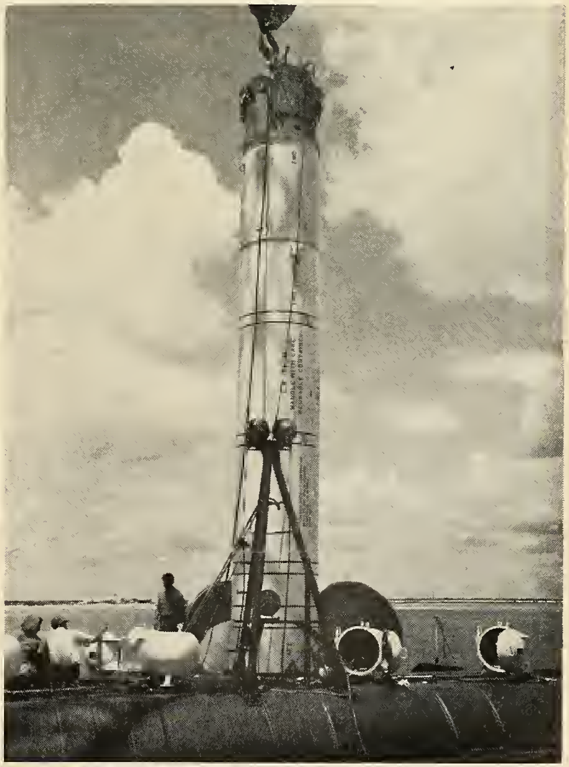
Land-based GSE for the operational *Polaris* fleet is centered at the Charleston, S.C., Missile Depot. The Navy is expected to build a similar depot on the West Coast for *Polaris* subs operating with the Pacific Fleet.



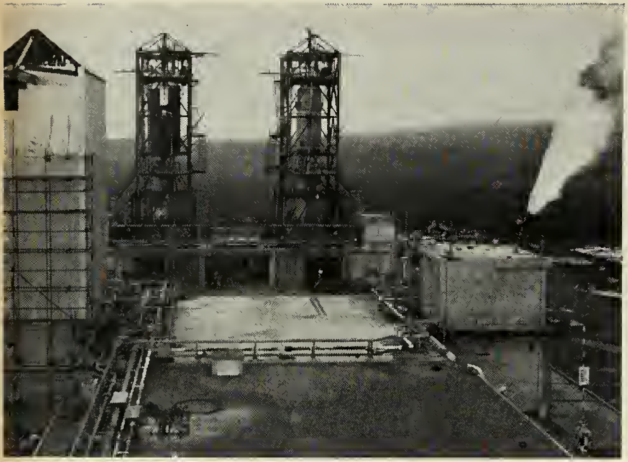
LAUNCHING TUBE for R&D Polaris missiles is one of two on the stern of the Test Ship Observation Island. This one can be tipped at a variety of angles.

RIGHT: *Loading a Polaris missile into the George Washington directly from a missile container. Underwater TV lights and cameras surround the mouth of the missile tube.*

ABOVE: *Visual observation of underwater launchings is further aided by additional lights and cameras rigged to stands on the submarine's deck at Port Canaveral for R&D Firings.*



Britain's Big Rocket Test Center



TEST AREA for engine components at Spadeadam includes two test stands and gas generator test cells.

ROCKET ENGINE Test Stands and Missile Tests Stand. Note the effluent lagoons in the foreground.

by G. V. E. Thompson

Four years of work, employment for 600 persons and at least $56 million will go down the drain unless Great Britain goes ahead with a space program and utilizes its Spadeadam Rocket Establishment.

Built for the assembly, development and test of the now cancelled *Blue Streak* LRBM, all construction work at Spadeadam has stopped. However, engine and vehicle testing is still continuing on a reduced scale until the government makes its long-awaited decision whether to proceed to develop *Blue Streak* as a space carrier vehicle or not.

The Establishment occupies about 10,000 acres set amidst pleasant, unspoiled countryside in an area drenched in history. It is on the Cumberland Fells about 20 miles northeast of Carlisle, and quite near the remains of Hadrian's Wall, Roman roads and forts, and medieval castles used in border disputes between England and Scotland.

The site was chosen as probably the only one of its size still available in England. The only alternatives would have been in the Scottish highlands. Although it is conveniently placed in relation to the Rolls-Royce headquarters in Derby, it has many disadvantages.

- **Bog and fog**—Being on the top of the fells, the weather is frequently wet or misty, and high winds are sometimes experienced. Maps of the area name it as Spadeadam Forest or Spadeadam Waste. The forest disappeared hundreds of years ago and was replaced by a bog. The bog is not dangerous to man but has caused difficulties during construction and increased costs. In building roads at the rocket site, ordinary methods were useless and the old Roman method of "floating" them on piles of brushwood was used.

The Establishment was conceived in 1955 and work began in December 1956. Construction was undertaken by the Ministry of Works to the requirements of the Ministry of Aviation, which specified the number of test stands and other facilities. The main contractors for the work were British Oxygen Engineering Ltd., and Wimpey Ltd. Later they formed a joint company.

Construction was mainly between January 1957 and January 1960, and all services had to be brought to the site. About 2000 workers were employed at the peak period of construction.

The Administration area is located near the entrance to the establishment, and includes offices, a small conference hall, laboratories (for testing effluents, checking instruments, etc.), a machine shop, and assembly shops. Component parts for the RZ1 and RZ2 engines come here from the Rolls-Royce works at Derby, Shrewsbury, Hucknall or Barnoldswick, Lancashire and are checked and assembled.

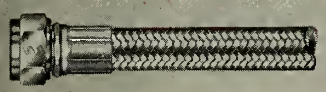
This LOX/kerosene engine is a development of the Rocketdyne S3, and was first run at the Rocket Propulsion Establishment, Westcott, in 1957. The first firing at Spadeadam took place 18 months ago. The early engines developed 135,000 lb. thrust, but this has been bettered. The dry weight of a single engine is about 1500 lb. and it is 10 ft. 7 in. high.

- **Like Atlas**—The building housing the engine assembly shop also has the missile preparation section, comprising three bays. Only one of these is in use. The *Blue Streak* bodies come from de Havilland Propellers Ltd. plants at Stevenage and Hatfield. Their design employs the same constructional principles as *Atlas*. De Havilland has an agreement with Convair.

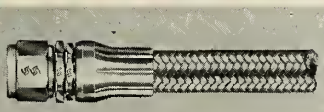
The missiles assembled do not contain a warhead. They have a frustroconical guidance section strengthened with external longitudinal ribs of top-hat section, a LOX tank without external reinforcement, a kerosene tank with "top-hat" ribs, and a skirt housing two Rolls-Royce engines.

The skin is made of thin stainless

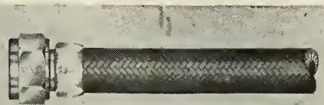
SPECIFY STRATOFLEX



SUPER-T TEFLON
124001-S-L
MIL-H-25579 Hose Assembly



SUPER "T-HP" TEFLON
129001-S-L
ARP 604 Hose Assembly



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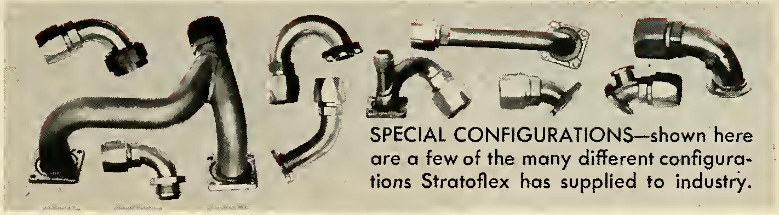
AN-6270 Hose Assembly
MIL-H-5593 Hose



SPECIAL CONFIGURATIONS—shown here are a few of the many different configurations Stratoflex has supplied to industry.

(Above hose assemblies conform in every detail to specifications listed.)

STRATOFLEX offers complete hose assemblies, hose and fittings in a wide range of sizes and types, allowing engineers exceptional freedom in equipment design. Stratoflex flexible hose and fittings are available for most fluid applications and for a wide range of pressures. Medium pressure Super-T Teflon* and high pressure Super "T-HP" Teflon* are designed for extreme temperature applications.

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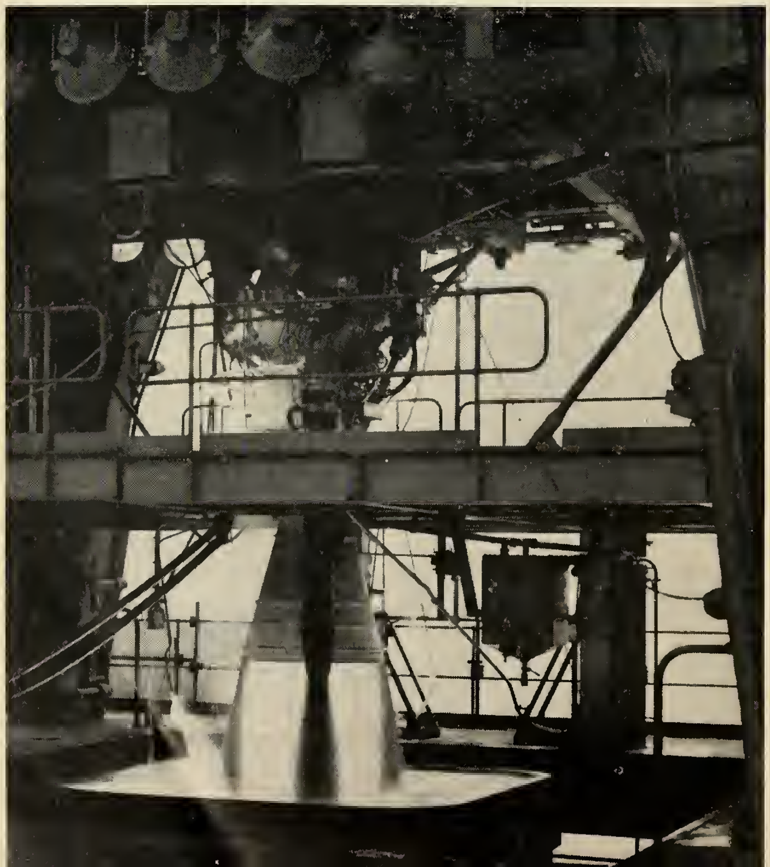
ABOVE: *Close-up of a Rocket Engine Test Stand.*

BELOW: *A rocket firing.*



steel sheet and the tanks are pressurized with nitrogen to prevent bucking. From the time of its manufacture until it is placed in the test stand or on the launch pad, the missile is also held in a frame. By attaching hydraulic jacks to this frame, the missile body can be placed under tension and the pressurization released while work is carried out on the body.

The LOX plant is operated and maintained by British Oxygen Gases Ltd. as agents for the Ministry of Aviation. It contains standard commercial equipment. There are two separate units, each producing 50 tons of liquid oxygen, 80 tons liquid nitrogen and 60 tons gaseous nitrogen per day.

Only one LOX unit is now operating.

LOX produced at the plant is stored in a 500-ton capacity tank and distributed by road tankers. The storage tank is insulated with Brellite powder, and fibreglass. The insulation is 4 ft. thick.

- **Component test area**—Sub-assemblies of component parts of the rocket engine are first calibrated and tested separately in the component test area, which has nine concrete test cells grouped around a central blockhouse.

The cell for testing gas generators has been closed down. The two turbopump testing cells are the only active facilities in this area. One cell tests the pumps with kerosene and water, which can be run to waste. The second cell uses kerosene and LOX. These are recirculated.

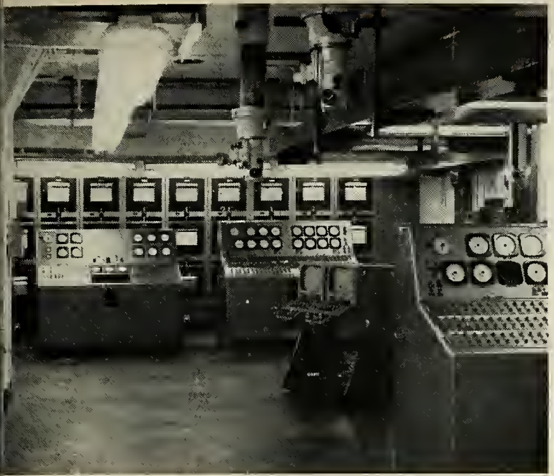
The rig in the cell for testing the gas turbine has not been completed and may never be. The turbine used is a 7500 lb. thrust engine developed by Rolls Royce for aircraft use and is termed superior to the original Rocketdyne equipment. A separate building contains a High Flow Water Test Facility, which is 95% complete.

Designed to be able to handle far larger engines, there is probably nothing as big in Britain. Its pumps can be used either in parallel or in series, giving either 6000 Imperial gal./min. at 300 psi. or 2000 Imp. gal./min. at 930 psi. This facility is intended for the calibration, with water, of flowmeters, injectors, combustion chamber jackets, etc.

The control room for this site has been instrumented by Pye Ltd. and is fitted with Honeywell-Brown chart recorders, closed circuit television, periscopes, etc.

- **Engine test area**—About a mile away is Site A, probably the most conspicuous part of the Establishment. This is a group of four engine test stands erected on a hillside and clearly visible from the Carlisle-Newcastle road.

Three of these (A1-A3) were erected



NGINE TEST Area Control Room equipped with chart-type corders, oscillographs, TV and periscopes.

ROCKET ENGINE Fitting Bay where Rolls Royce LOX/-kerosene engines are assembled for the Blue Streak.

ccording to American practice at the me of designing the plant. These are paced 250 ft. apart and each consists f a massive concrete and steel strucure in which the rocket engine can be nounted to fire vertically downwards nto a water-cooled steel flame deflecor. LOX and kerosene tanks are placed ertically over the engine as in the nissile.

The fourth stand has been designed uite differently. Experience showed hat safety precautions on A1-A3 were xcessive. It is more squat, with proellant tanks at ground level on each ide of the stand (permitting direct oading from tankers), much less masive and situated quite near to stand 3. This structure is of prestressed oncrete.

Water from the deflectors passes via oncrete spillways to a treatment plant, vhere any solids and kerosene are renoved and the water stored for reuse.

A control blockhouse is 600 ft. way from the A1 test stand. The buildng is constructed of 2-ft. thick reinorced concrete and equipped with 130 hart-type recorders, four 24-channel scillographs, closed circuit TV and eriscopes. When completed, there will e eight control consoles.

An underground concrete duct, 7 ft. quare and 1100 ft. long connects he test stands and control room for he routing of 8000 instrumentation and ontrol cables.

As the missile test area is incomlete, the A1 engine test stand was conerted some time ago for temporary use s a missile test stand. This has a large ixed tower and is fitted with a missile iring pad, although not an exact replica f the ones to be used at Woomera.

Missiles attached to the carrier rame are brought to the stand by road n a transporter, a pivot attachment bolted on the end of the frame, and this winched up by hand into a vertical position. The *Blue Streak* is then a few yards in front of the firing pad.

A carrier ring is bolted to the top of the missile, and it is then hoisted up free from the frame by this ring, swung into position above the pad and lowered into place.

• **Missile test area**—About 1¾ miles away is Site C, the Missile Test Area. This has two widely separated missile static test stands, C3 and C2, each having a transversing servicing tower, incorporating a gantry for elevating the missile into the vertical firing position. The tower can be withdrawn along a 300-ft. concrete causeway.

Stand C2 is incomplete, but C3 is virtually completed except for electrical work. The launcher is virtually the same as those used for actual launchings in Australia, except that there is no provision for releasing the clamping jaws holding the missile to the pad.

The towers have portal frames open on both sides. There are the usual servicing platforms, each being divided into four quadrants. The quadrants can be operated independently (although usually all are raised at once), but those at different levels are not independent. All the levels in any given quadrant rise together.

Neither stand has been used yet. Equipment for refrigeration, power supplies, instrumentation, air conditioning and control electrics is ready for installation beneath C3 if the word is given to go ahead. The equipment rooms could be ready in a few months.

A central blockhouse is located 1000 ft. from the stands. Except for a Rolls-Royce engine panel, the instrumentation here was designed and installed by de Havilland's. The main system comprises 19 control consoles, 4 checkout consoles, 27 chart controllers with a capacity of 216 channels. Over 3500 cables connect the control center with each test stand.

Bark and Stroud observation periscopes have been installed, and there are also episcopes and closed-circuit TV. Film records of the tests are made by cine-cameras installed around the test stand.

• **Management**—The Ministry of Aviation has vested the management of the Establishment in Rolls-Royce Ltd., which is responsible for overall supervision, the provision of essential services for all users, and maintenance. The site manager is Cmdr. Adams. Total staff employed by Rolls-Royce, de Havilland and British Oxygen at the site is about 600.

The exact cost of the Establishment is not known, but is probably around $56 million. Some newspapers recently carried stories that equipment at Spadeadam had been auctioned. But it turned out that contractors who had finished work at the site had been disposing of surplus equipment.

Two test firings of twin-engine units were made during a press visit this month. In the first, the unit ran for three seconds and was then cut out by automatic equipment because the fuel supply to an igniter failed to register the required pressure.

In the second, the engines ran normally. The unit is fitted with various automatic devices including one which ensures that firing does not take place unless both engines are working satisfactorily.

The complete *Blue Streak* vehicle has been successfully tested and if government approval were given it would be possible to ship several to Australia for actual launching. Conversion for satellite launching could come later.

CONTENTS:
accuracy in pressure measurement

Here's the starting point for precision calibration of pressure measuring instruments... here's where accuracy begins. It's CEC's portable 6-201 Primary Pressure Standard, a pneumatic dead-weight piston gage that assures resolution of 0.005% of reading.

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For complete information on the 6-201, write for Bulletin CEC 1581B-X28. For data on CEC's integrated line of instrumentation and pressure measurement devices, ask for Bulletin CEC 1308-X18.

Transducer Division CEC

CONSOLIDATED ELECTRODYNAMICS/pasadena, california

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Big Hydrofoil

200-ton ASW Vessel Due in 18-20 Months

A 200-ton hydrofoil warship will soon be developed by the Navy. The craft will be a follow-on to a 110-ton hydrofoil warship now under preliminary design by Boeing and Martinac Shipbuilding of Tacoma, Wash.

Rear Admiral R. K. James, Chief of the Navy's Bureau of Aeronautics, bills hydrofoil craft as a new species of warship that will at last put the surface vessel back in the competition for antisubmarine warfare work. The breakthrough came with the recent development of hydrofoils that can operate completely submerged rather than skimming across the water surface.

The Boeing-Martinac vessel is being built under a $2-million fixed-price contract awarded last June. The preliminary design stage is expected to be done a year from now and the craft "put together in six to eight months after that."

It will be 115 feet long and have 110 tons displacement. James describes it as traveling 50 to 55 knots and carrying target-seeking torpedoes and sonar gear.

• **Marriage broker**—He called the Navy's interest in hydrofoils an "opportunity" for the "lagging aircraft industry." Adding that for this work a marriage is needed between aircraft builders and ship builders, he said at a luncheon last week that "when tenders for bids went out (for the 110-ton craft). I called for an aircraft company and a shipyard combination to get the contract."

Reasons are that the aircraft industry is experienced in building lightweight structures able to maximize the payload-to-gross-weight ratio; while the shipbuilding industry has a knowledge of the design of displacement vessels.

James emphasized that there are many difficult problems to be solved by designers of the 200-ton craft. These include combining aircraft and marine experience in devising the powerplant; developing unique designs for lightweight structures; contriving an adequate power transmission system, "perhaps through the use of water jets"; and solving the treacherous strength-of-materials problem that arises in supporting a large gross weight on stilts.

He foresees a requirement of 80 to 90 knots for the hydrofoil. This takes the submerged airfoil surfaces into the "supercavitating airfoil design region," where not much experimental or theoretical work has been done.

High praise was given to a control device involving an altimeter that measures the vessel's height above the

←Circle No. 30 on Subscriber Service Card.

water and then appropriately and continuously adjusts the aspect of the submerged wings.

Because of the technical problems involved in designing a hydrofoil craft, James estimates that 500 tons probably marks the upper weight limit for the species. However, the hydro-skimmer or ground-effect machine, "though looked upon with less optimism than the hydrofoil, can theoretically go upward of 2000 tons gross weight."

The Boeing-Martinac hydrofoil is powered by two 3000-horsepower Proteus gas-turbine engines. For slow non-hydrofoil speeds, the drive comes from a 600-horsepower marine diesel.

AF Streamlines

Weapons System Concept Gets New Coordination

The Air Force's systems management concept is being streamlined to allow concept-to-production regulation of a weapons system by a single planning and programing document.

The new regulation, AFR 375-1, provides for "System Staff Offices" (SSO's) at AF headquarters and "Systems Program Offices" (SPO's) to coordinate field activity in weapons development.

The new SPO's most closely related to the superseded Weapons System Project Offices, to be phased out of weapons and support system management organization as soon as projects under their direction are completed.

Development of new weapons will proceed from the SSO's to the SPO's with systems management cutting across many functional groupings in the AF, including: plans, operations, research, development, production, supply and maintenance and personnel. These functional commands will be directed to support "systems management" through the system staff officers at headquarters level and through the system program director at field level.

In an effort to reduce change-of-command red tape, the new regulation encouraged direct communication throughout the AF in support of systems programs: "Direct communication is authorized among commands participating in system programs. Routine direct contacts at working levels among system and functional managers are encouraged."

Normally, ARDC will be assigned overall program managership during the development and production phases. Prime responsibility will usually devolve on the Air Materiel Command after delivery of first production items to the user. AF headquarters will establish initial management responsibility, designating either ARDC or AMC as the program requires.

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NEW TARGET MISSILE—Two missiles in one, this high or low level supersonic target missile for U. S. Army is now in development at Columbus Division. Launched by solid booster, ramjet-powered, it performs from subsonic up through Mach 2, and from ground level to 60,000 feet. NAA Columbus also produces Navy's A3J Vigilante, world's most versatile Mach 2 manned weapon system, and the T2J Buckeye multipurpose jet trainer.

THE COLUMBUS DIVISION OF
NORTH AMERICAN AVIATION, INC.
Columbus, Ohio

Technical Countdown

ELECTRONICS

Temp. Range Doubled for Electronic Eyes

Reliability of light-sensing devices for space vehicles operating in high temperatures will be considerably improved by a new photoemissive material developed at Westinghouse. Operational range is reported to be around 120°C—about twice that of present types.

Saturn Radio Emissions Measured

Radio waves from the planet Saturn and from a planetary nebula have been measured by U. of Michigan scientists. Such measurements are expected to shed light on the temperature and density of Saturn's rings and on the distribution of gases in the planet's atmosphere.

High-Speed Light Source Developed

A 0.3-microsecond light source for photographing high-speed phenomena has been developed by Avco RAD. The source can be used with shadowgraph or Schlieren systems to illuminate and "stop" reactions of models, gases, or chemicals in hypervelocity research studies.

Millimeter Power Outputs Increased

A new approach to the generation of "substantial" power outputs in the millimeter region (EHF and above) has proved successful in AF-sponsored research at U. of Illinois. The new technique—using Cerenkov radiation—has produced 300 milliwatts at the tenth harmonic of 2.77 kmc. Researchers feel that outputs as high as 10 watts are within reach with the new method.

Study of Cosmos Continues

A 10-telescope, 250-lb. astronomical payload will be launched from Woomera next year. The U.S.-Britain-Australian joint venture will attempt to observe that part of the cosmos seen from the Southern Hemisphere. British *Skylark* rockets will carry the package vertically to 100 miles. Bids on 4 payloads (due for delivery six months following contract award) were received Sept. 12 by NASA.

Orbital Chaff Chafes Briefly

Proposed use of metallic-fiber orbital path for scatter communications has drawn only flash concern from radio astronomers. The concept was presented by W. E. Morrow, Jr. of MIT's Lincoln Laboratory before the International Scientific Radio Union in London, Sept. 9. Apparently all objections based on possible interference characteristics can be overruled scientifically.

Methods Outlined for Upping Solar Cell Efficiency

Techniques for increasing the efficiency of solar cells are described in a new report to be distributed soon by Bausch & Lomb. This is the first in a series of reports to scientists on new techniques and development of materials, systems, components and other areas associated with optics research.

PROPULSION

Rocket System Study Bids Due Soon

NASA's Langley Research Center is asking bids by Sept. 30 on a study of performance and reliability of sounding rocket systems. Sixteen systems and 20 motors will be covered in the 3½-month study.

MATERIALS

Beryllium Shingles Picked for Mercury

NASA's Space Task Group has switched from ribbed titanium as the outer skin of the *Mercury* capsule. The lower cone will be Inconel and the cylinder will be beryllium shingles.

Titanium Wrapped for High Strength

Titanium pressure vessels are being tape-wrapped by Borg-Warner. The cases reportedly reach tensile strengths of 350,000 to 380,000 psi.

Filament-Winding Advance Announced

Tapco Group has produced filament-wound reinforced pressure vessels with integrally wound closures having a strength-density ratio in excess of 3 million inch-pounds per pound. This corresponds to a unidirectional strength of 340,000 psi in the fiber resin system.

Really Solid Ceramics Developed

Superdense ferroelectric ceramics with 80% of the voids eliminated result from a new technique at Gulton Industries, Inc. One-piece transducer discs up to 20 in. in diameter are possible with the method.

Bomarc Gets New Alloy

Advanced versions of the *Bomarc* will use alloy 2219, a strong, heat-defying aluminum composition. The metal will be used in the missile's combination fuselage-fuel tank.

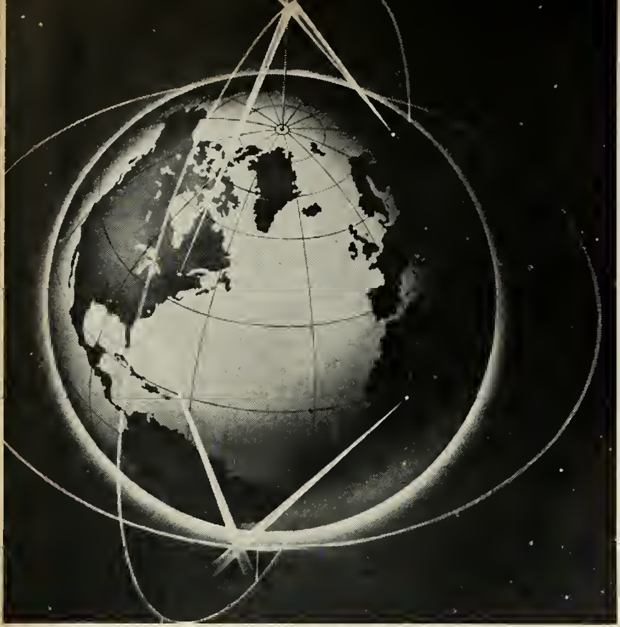
New Glass Yields Minimum Radiation

Measurement and identification of extremely tiny amounts of radiation will be possible with a new glass developed by Corning Glass Works. With a radioactivity of less than 10 counts per minute per kg, as compared with 175 for current glasses, the new material is slated for use in photomultiplier tubes.

HUMAN FACTORS

Slow Decisions Get Wrong Answers

Human factors research is telling astronauts to trust their first conclusions. In recent testing managed by psychologists and confirmed by the AF Office of Scientific Research, it took subjects working on one problem an average of 376 seconds for correct response, 486 seconds for the wrong answer.



Metal Fibers Urged For Communications

Proponents see orbiting belts as highly reliable means for reflecting transmissions

ORBITAL SCATTER belts will permit very long distance telecommunication transmissions. Their tiny metal fibers (dipoles) will be thousands of feet apart.

Two relatively stationary belts of orbiting metallic fibers have been proposed as a reflector-scattering mechanism for a long-range microwave communications system.

It is believed that the reflective properties of two perpendicular belts of the tiny metal fibers in a 3000-6000-mile orbit would implement extremely reliable long distance worldwide telecommunications.

In addition, its proponents offer other advantages of such a system: "modest" ground antenna tracking requirements and the ability to support a large number of independent circuits.

The concept—originated by W. E. Morrow, Jr. of M.I.T. Lincoln Laboratory and H. Meyer of Thompson Ramo Wooldridge Corp. in 1958—has developed from basic idea to a practical project in just two years. A discussion of the program based on the 2-year study was presented by Morrow on September 9 before the Thirteenth General Assembly of the International Scientific Radio Union in London.

Morrow's paper deals principally with a "hypothetical" system but while the values mentioned are representative the techniques to be employed are firm.

This briefly is a description of the orbital scatter technique:

Almost any good electrical conductor could be used for the metal fiber material. For a long-term system, copper wire would be practical. But, for experimental paths a white tin alloy has been suggested which would gradually turn to a powder and disintegrate with time. Solar radiation pressure would cause the dust to reenter the earth's atmosphere in a relatively short time.

Each fiber would be a tuned half-wave dipole, over 1 cm. long and having a diameter of 3x10^{-3}cm.

One rocket launched container carrying about 100 kilograms of metal fiber would be needed for each path. After attaining a satisfactory orbit, the container would steadily release its contents.

Dipole distribution according to Morrow could be effected in a period of one or two months if dispensed with a distribution of velocities up to a few meters per second.

- **Broad coverage**—Optimum coverage probably would be achieved, said Morrow, with one equatorial and one polar circular orbital path.

With orbital heights of from 5 to 10 thousand kilometers, single-hop communication could be established between Europe and most of North America and Asia. Coverage areas, however, would be best on north-south circuits.

Most of the globe could be covered with two-hop circuits. The one exception, said Morrow, is the connection of locations near one pole with those near the other. A three-hop connection would be required in this case.

Dipole dispersion is estimated at 40 km. radially in 60 days, 100 km. in a year. Transverse dispersion would be more rapid and would no doubt limit useful life of the path to about 2 years. (With only radial dispersion to contend with, lifetime might exceed ten years.)

Typical ionospheric or tropospheric scatter transmitting and receiving equipment could not be used for orbital scatter. Many of the techniques might be borrowed, however.

The proposed system would operate at a specific frequency between 5 and 10 kmc with a bandwidth adequate for five high quality voice channels.

Transmission power probably would be about 10 kw using 20-meter high gain paraboloidal reflector antennas.

By employing dual or triple-diversity receiving antenna systems and MASER or parametric amplifier front end techniques to reduce noise satisfactorily, highly reliable performance would be attained.

For example, the author estimated that such a system would permit a digital transmission rate of about 10,000 bits/sec. with an error rate of about 10^{-5}.

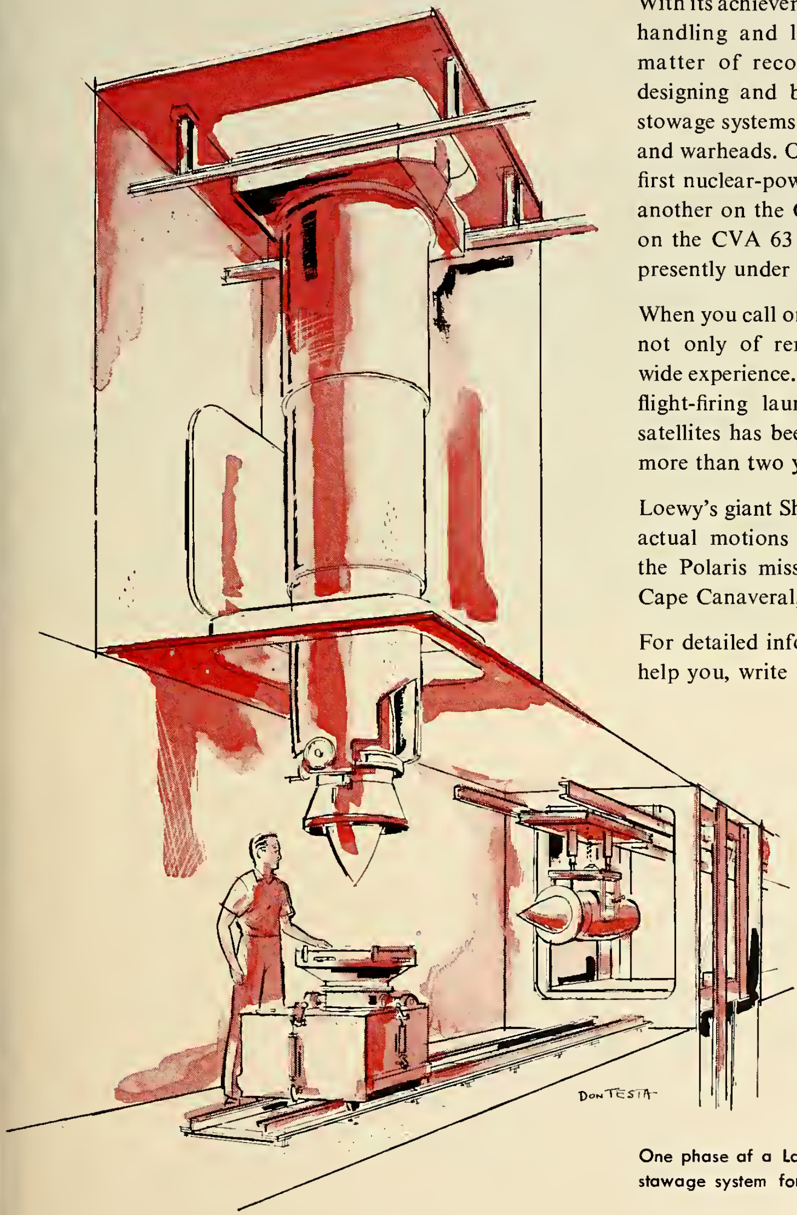
By increasing the mass of orbital scatterers, and using larger ground installations Morrow believes capacities up to 10^{6} bits/sec. might be achieved.

There has been "flash concern" from radio astronomers and others, a Lincoln Lab spokesman told M/R, about the use of such a system as Morrow suggests. All of these temporary objections—impact with spacecraft, effects on optical and electronic ground systems—have been investigated and believed eliminated.

The introduction of 100 kg of metal fiber appears extremely insignificant when compared with the several thousands of tons of cosmic dust and other debris accumulated each day from outer space.

It is also significant to note that 9 oz. of the metal fibers offer the same reflective quality as the 100 ft. diameter *Echo* balloon.

For Terrier and Talos missiles and warheads . . . new shipboard handling and stowage systems by Loewy



With its achievements in missile and rocket ground handling and launching equipment already a matter of record, Loewy-Hydropress is now designing and building shipboard handling and stowage systems for the Terrier and Talos missiles and warheads. One system is to be installed on the first nuclear-powered cruiser, U.S.S. *Long Beach;* another on the CG 10 Class cruisers; and a third on the CVA 63 Class aircraft carriers, which are presently under construction.

When you call on Loewy, you are availing yourself not only of remarkable ingenuity, but also of wide experience. The Loewy system for testing and flight-firing launching vehicles of earth-circling satellites has been functioning without failure for more than two years.

Loewy's giant Shaker installation, which simulates actual motions of seagoing ships for test-firing the Polaris missile, is in successful operation at Cape Canaveral, Florida.

For detailed information on how we can possibly help you, write Dept. S-9.

One phase of a Loewy handling, mating and stowage system for warheads on shipboard.

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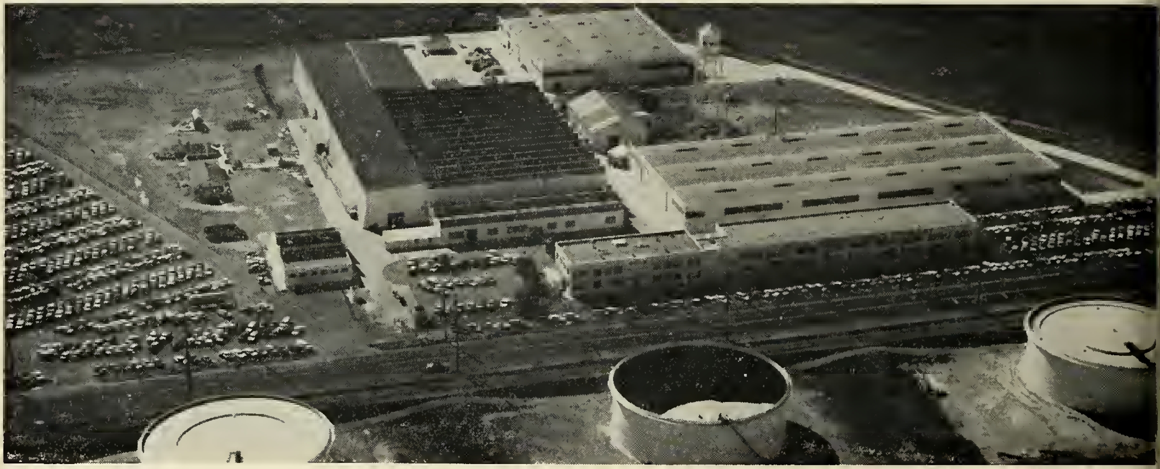
Ryan's Explosive Electronics Growth

Company is developing into a prime contender for system contracts with vast expansion in electronics and other areas



PRODUCTION FACILITY of Ryan's Electronics Division at Torrance, Calif., is base for recent boom in Electronics.

SAN DIEGO, CALIF.—Ryan Aeronautical Co. is using a booming growth in its electronics business as the base for development into a prime contender for systems contracts in the missile/space field.

The company's electronic sales in fiscal 1959 totaled $5-million. This year, they will total some $35-million and electronic growth over the next two years is expected to be at a rate of 20% a year.

To complement this explosive electronic expansion, the company's new management team has broadened Ryan's other interests to provide a strong overall systems capability:

–Acquisition of Aerolab Development Co. for missile airframe and design know-how.

–Establishment of Ryan Transdata, Inc., as a subsidiary puts the company in the data handling field.

–Manufacture of high-temperature aircraft, missile and rocket engine components, including rocket chambers for Grand Central Rocket's *Viper* and combustion chambers for Marquardt's ramjet engines, has provided propulsion know-how.

–Large airframe subcontracts have given the firm a background and experienced labor force in modern production-line and metal-working techniques. Emphasis has been placed on advanced materials research and such new manufacturing approaches as explosive forming.

–Continued development of the successful *Firebee* jet-powered target missile system and of vertical takeoff aircraft has given the firm experience in overall systems makeup.

–And last, but far from least, introduction of new blood at top administrative and technical levels has brought together a management team able to cope with the Ryan growth pattern.

For the first time in many years, the majority of Ryan's contracts in 1960 are prime contracts—55% against 45%. Last year, 60% of the firm's business was still in subcontracts.

After a perusal of the company earlier this year, the Philadelphia investment firm of Robinson & Co. reported: "The caliber of Ryan management is evident from its excellent record of sales and earnings, the forme having increased from $15-million in 1949 to $85-million in 1959, whil earnings have increased eight fold. I net return on invested capital, Rya ranks among the best in the nation.'

• Electronic pace—A compan official says: "The missile/space business is our business now."

Behind all this is the growth in electronics—from 5% of gross income i 1959 to the point where it today i the company's largest single class o product.

At the beginning of 1958, Rya still was known in the industry largel for its reputation as a builder of Worl War II training planes and its competence as a subcontractor on airframes and aircraft engine component There were only 100 people in th electronics department. Nearly 70% o Ryan's business consisted of airfram and engine subcontracts.

When it came, the move awa

from the dwindling aircraft market was swift. The big electronics push began in 1958, with 1959 as what one division official calls "the real backbreaking year" in electronic growth.

In that year, employment in the electronics division jumped from something like 700 at the beginning of the year to nearly 2000 at year's end.

- **Team members**—Much of the credit for the change in the San Diego firm goes to a new management team put together by promotions from within the company and by recruiting from outside. Under president T. Claude Ryan, its members include:

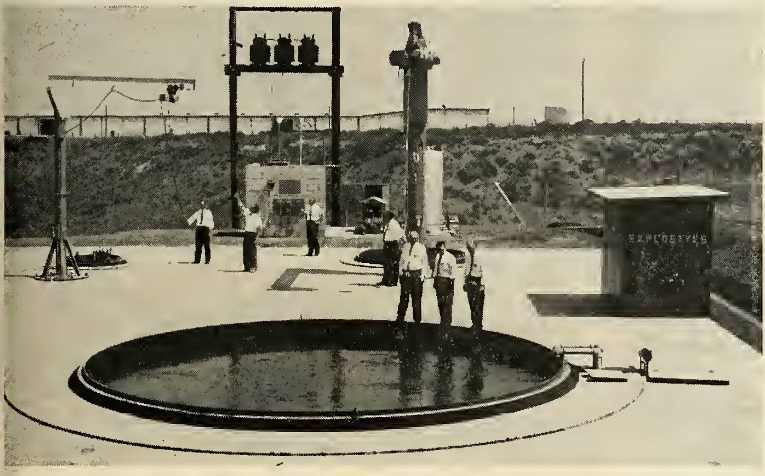
Robert C. Jackson, named executive vice president and vice chairman of the board late last year. Jackson's background is financial. He is vice president and director of Emtor, Inc., an investment holding company which holds the largest block of Ryan stock, more than 300,000 shares. He also is vice president of West Shore Co., another Los Angeles investment holding company, and president of several other financial firms, including South Shore Co., which specializes in real estate mortgage loans.

Edward G. Uhl, who joined Ryan last year as vice president-technical administration. Uhl formerly was vice president-general manager of the Martin Missile Division at Orlando, Fla. With Martin 13 years, working up from research engineer, he was responsible for construction of the missile facility for production of the Army *Pershing* and *Lacrosse* ground-launched missiles, Navy *Bullpup* air-launched missile, and the Missile Master Data processing system.

Lloyd Everingham, who joined Ryan early this year as space laboratory director with responsibility for operating the Aerolab facility. Everingham formerly was vice president in charge of research at Radiation, Inc., in Florida.

Frank W. Fink, vice president-engineering, who joined Ryan in 1955. He formerly was chief engineer of Convair-San Diego, and was in charge of the original *Terrier* and *Atlas* missile programs.

William G. Alexander, president of the recently-announced Transdata subsidiary. Alexander was San Diego general manager of the Stromberg-Carlson division of General Dynamics.



RYAN OFFICIALS inspect new high-energy forming facility at Kearny Mesa.

G. W. Rutherford, vice president and general manager of Ryan Electronics. He has been an officer of the company since 1955, when he was named assistant controller, and has been manager of Ryan Electronics since it was established as a separate division in 1957.

Owen S. Olds, director of engineering and customer relations, Ryan Electronics. In addition to work on other electronic devices for missile programs, Olds has had primary responsibility for technical development of continuous wave Doppler systems at Ryan for 14 years.

John W. Rane, Jr., named director of military relations last year. He joined Ryan after 18 years with Bell Aircraft, where he served as director of engineering and sales, and assistant vice president.

The manner in which the company has been combining old and new in assembling its potent new team can be seen from recent appointments to three top posts at Aerolab. The new chief engineer, Forrest Warren, and financial manager, William Fischer, totaled 16 years with Ryan between them. But the company went outside for the administrative engineer, Frank Bolles of Cornell University Aeronautical Laboratory.

- **Electronics Division**—Production of electronics components, sub-assemblies and C-W (continuous wave) Doppler systems is concentrated in the division's Torrance, Calif., plant not far from Los Angeles. Engineering, research and development, advance design and testing is carried out at the division's Kearny Mesa headquarters.

The two plants contain some 370,000 sq. ft. of working area, including one of the most up-to-date electronic test facilities in the nation.

Ryan got into the electronics business by pioneering C-W Doppler navigational guidance systems on the Air Force's first air-to-air research missile, the Ryan *Firebird.*

The new concepts it found in this field had important applications which Ryan still is developing, although for a long while C-W took a back seat to pulse radar. C-W, however, will do some things pulse radar will not and the latest generation equipment is lighter and more accurate. An important step forward was the development with Varian Associates of the klystron tube.

"We're just now getting into a real delivery position and gearing to even higher production at Torrance," an electronics division official says.

"We sell units, not systems," he says. "We advertise and sell interchangeability. We sell units that make up systems. There's an important little difference there in philosophy."

It's a successful little difference: in one six-week period recently, something like $20-million in new business was logged in by the division.

Torrance is turning out AN/APN-122(V) radar and navigation sets on which orders now are approaching 1000; AN/APN-97 helicopter hovering and ground velocity indicators, primarily for all-weather and ASW work, on which orders exceed 400; AN/APN-130 sets, similar to the APN-97 but with additional navigation and altitude capability and increased accuracy, on which orders top 350; and AN/APN-129(V) lightweight navigation sets for U.S. Army Surveillance aircraft.

- **Aerolab Development Co.**—Aerolab pioneered in the field of low-cost, high-performance sounding rockets utilizing off-the-shelf components to build missiles into multi-stage space probes. It was a prime contractor to the Air Force Special Weapons Center, Kirtland Air Force Base, on Project *Jason*. The project was for measurement of radiation effects of the Project *Argus* nuclear explosions in the South Atlantic. The Aerolab *Argo E-5* five-stage sounding rocket was used.

Under an Air Research and Development contract, it put together a four-stage D-4 sounding rocket in Project *Javelin* to measure the Van Allen radiation belt. This program carried telemetry equipment and supporting hardware to heights of 2000 miles.

In the NERV (Nuclear Emulsion Radiation Vehicle) program, General Electric and Aerolab are prime contractors to NASA in studies of the Van Allen belt with a 125-lb. GE instrumentation package boosted by an Aerolab Argo D-8 *Journeyman* rocket.

Adventurer and *Percheron* series rockets under development at Aerolab will carry payloads beyond 4000 miles.

- **Ryan Transdata, Inc.**—Specializing in the design and development of data handling equipment, this new subsidiary initially is undertaking design studies of equipment aimed at office automation—the transfer of data from a central storage center to an executive's desk, where it is displayed on read-out equipment. But applications include supervisory monitoring and command control of space vehicles.

Space Age capabilities in the home plant at San Diego's Lindbergh Field include work with ultra-thin gauge. high strength materials in the firm's Mini-Wate and MicroWate development programs. These were developed to meet the tremendous stress, temperature and weight limitations imposed by hypersonic flight speeds. Ryan recently completed work on a contract from Wright Air Development Division studying application of these materials to a vehicle capable of operating at extremely high altitudes, possibly in something such as a solar sail. The contract included construction of a test structure.

A new high-energy forming facility recently went into production on a 20-acre site on nearby Kearny Mesa. Ryan has been working for two years in the explosive forming field and is recognized as a leader in the technique. One contract calls for turning out large hemispherical bulkhead for *Saturn* fuel tanks as much as 70-in. or more in diameter.

Ryan, with a fresh new management approach, is wrapping all these capabilities into a bid for recognition as one of the missile/space firms capable of handling integrated system contracts. If its accomplishments of the next three years are of the same magnitude as the last three, it should have little difficulty in winning that recognition.

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TYPE PR-203 PREAMPLIFIER

TYPE SOU-300 SPECTRUM DISPLAY UNIT

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mergers & expansions

RYAN AERONAUTICAL CO. has formed a subsidiary to specialize in design and development of data handling equipment. The new company, Ryan Transdata, Inc., will be headed by William G. Alexander, former general manager of Stromberg-Carlson Div., General Dynamics.

NORTH AMERICAN AVIATION has purchased Temptron, Inc., Reseda, Calif. NAA will operate the thermocouple manufacturing firm as a wholly-owned subsidiary.

FLUOROCARBON CO. has moved its entire Fullerton plant to new and larger quarters in Anaheim, Calif.

TRAK ELECTRONICS CO. has formed a new subsidiary, Trak Microwave Corp., in Tampa, Fla. Operations in the new plant will start Oct. 1.

VARO MFG. CO., Garland, Tex., has purchased all the stock of A. G. Optical Co. of Chicago.

PERKIN ENG. CORP. has changed its name to Perkin Electronics Corp. Dynex Industries, Inc. of Long Island is negotiating for acquisition of Documat, Inc., of Belmont, Mass.

SILVERCROWN, LTD. of London has been licensed to manufacture the complete line of Technic precious metal plating products in England, for sale in England, the Commonwealth except Canada, and throughout Europe.

ZERO MFG. CO. has completed construction of its $500,000 Modular Container facility in Burbank, Calif. The 33,600-sq.-ft. building will contain about $250,000 worth of new manufacturing equipment.

ELECTRADA CORP. has acquired Airite Products, Inc. of Los Angeles. The acquisition brings the number of Electrada divisions to five, including Stillman Rubber Co., Airite Products Inc., Product Packaging Engineering Div., and two electronics divs., Information Systems and Research and Electronic Manufacturing and Engineering.

ANALYSTS, INC., the first commercial chemical laboratory designed especially for the scientific control of engine maintenance, has been established in Oakland, Calif.

PARMATIC INC. has selected a site at the Municipal Airport, Watertown, N.Y., for a new plant and headquarters facility.

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Aerospace Delays Laid to Schedule

Slow pace of recruiting is now picking up; official denies that STL men are reluctant to transfer to new firm

by William J. Coughlin

EL SEGUNDO, CALIF.—Delays in the organization of Aerospace Corp. appear to lie with an overambitious schedule laid down by the Air Force rather than any specific problems in attracting employees to the new concern.

Aerospace, formed as a non-profit corporation to supplant Space Technology Laboratories in USAF missile/space programs, has been forced to subcontract Air Force work to STL due to a personnel shortage (M/R, Sept. 12, p. 9).

At the beginning of this month, Aerospace had succeeded in recruiting only 520 of the 1400 employees expected to be on the payroll by then. Of a planned 300-member technical staff, only 76 had signed up.

Although STL sources report that some of that firm's technical staff members have been reluctant to transfer to Aerospace, a spokesman for the new company denies that this has been a major factor delaying organization of the new firm.

"Of course, we wish we were a bit further along than we are," a senior company official told M/R, "but the fact we are not is not due to any difficulties other than those of trying to get an infant born full-size all at once."

• **Pace quickens**—The new Aerospace president, Dr. Ivan Getting, formerly vice president for engineering and research at Raytheon Co., did not report until Aug. 1. Recruiting of senior staff could not really get under way until his arrival—and this slowed the overall organizational effort.

The recruiting pace now is accelerating, a company spokesman reports, but no estimate is available on when the 1400 staff level will be reached. Size of the technical staff doubled in the week preceding Sept. 6—from less than 40 to 76.

An effort was made to select STL technical staff for transfer to Aerospace by IBM machine on the basis of the amount of time put in on projects which were transferred.

"But you cannot attract and motivate a competent technical man by IBM card," an Aerospace official admitted. It also was found that the "man/day" reported by IBM card frequently was not that of one man but portions of the time of two or three men.

In addition, the Air Force did not want to put Aerospace in a position of "raiding" the STL staff by force at the very time STL was setting out on its own in commercial competition. Aerospace, trying to avoid being merely a reincarnated STL, also has made an attempt to recruit outside talent to supplement the transfers from STL.

• **$30 million/year**—Dr. Getting says he expects Aerospace Corp. to be a "going organization" by the end of the calendar year. He estimates the ultimate staff figure may be around 3000 on an annual budget of $30-million; but he emphasizes that these are only estimates.

Aerospace still is operating under a letter contract with the Air Force Ballistic Missile Division, dated July 1. This is to be superseded by a definitized contract. What the dollar volume of this contract will be has not been announced.

"As long as we are talking about a total Air Force spending of about $3-billion annually for Space Age systems—including ballistic missiles—then it is unlikely that our budget would be less than one percent of that, or $30-million a year," Getting says.

Aerospace Corp.'s subcontracts with STL are on an interim basis—"almost a weekly basis"—a company official told M/R. STL has made it plain it is anxious to get rid of them as soon as possible.

Some of Aerospace's support personnel—such as security guards and secretaries—were transferred en bloc from STL when the projects to which they were assigned were transferred. The company has been recruiting its technical staff from STL in two categories, those who were on a "list of invitees" whose jobs were transferred and those who have volunteered.

• **Careful changeover**—At the same time, STL and Aerospace are working closely together in an effort to avoid bidding against each other for the services of the same man.

Senior officials of the new corporation include vice president-administration W. W. Drake, formerly with Raytheon; senior vice president-technical Allan F. Donovan, formerly with STL; vice president-technical Jack Irving, formerly assistant to Donovan at STL; and director of government relations Dan Whitcraft, formerly with General Electric. Beverly Hills attorney Najeeb E. Halaby is serving parttime as corporate secretary.

• **Division of roles**—Aerospace was incorporated in California as a non-profit corporation on June 3. Its charter provides that its nature is "exclusively scientific to engage in, assist and contribute to the support of scientific activities and projects for, and to perform and engage in research, development and advisory services to or for, the United States Government."

It was announced at the time of Aerospace Corp.'s formation that it might later take on contract work for National Aeronautics and Space Administration and other government agencies, in addition to its duties for BMD.

Aerospace is taking over only a small portion of the work done for BMD by STL. STL contracts for systems engineering and technical direction of the *Atlas*, *Titan* and *Minuteman* weapon systems are being continued to avoid disruption in the programs. Aerospace is, however, assuming these roles in the *Discoverer*, *Samos* and *Midas* programs, in addition to branching out into new areas of missile and space technology. (M/R, July 4, p. 10.)

Aerospace has taken over a portion of the facilities at STL's El Segundo Research and Development center and the Air Force has re-affirmed its decision to buy the entire facility from STL.

"Space certainly is going to be a problem and how it will be relieved, we don't know yet," a company spokesman said. An exclusive story in AVIATION DAILY reported recently that the Air Force was looking for a new site for expansion of its ballistic missile management team.

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The Transmitter Group consists of 3 components: Basic 4-Watt Transmitter, Power Supply, and 15-Watt Power Amplifier. Installation in airborne vehicles where space is limited mounts these conduction-cooled units on an aluminum plate which in turn is mounted with good thermal contact to the airframe which acts as a heat sink.

FEATURES

- *Frequency Stability:* ± 0.005% (all environmental conditions)
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This Receiver provides simultaneous AM and FM video, pre-detection 10 mc IF frequency, signal level recorder, and 60 mc IF for operation of a GEL Type 24A1 Frequency Display Unit.

FEATURES

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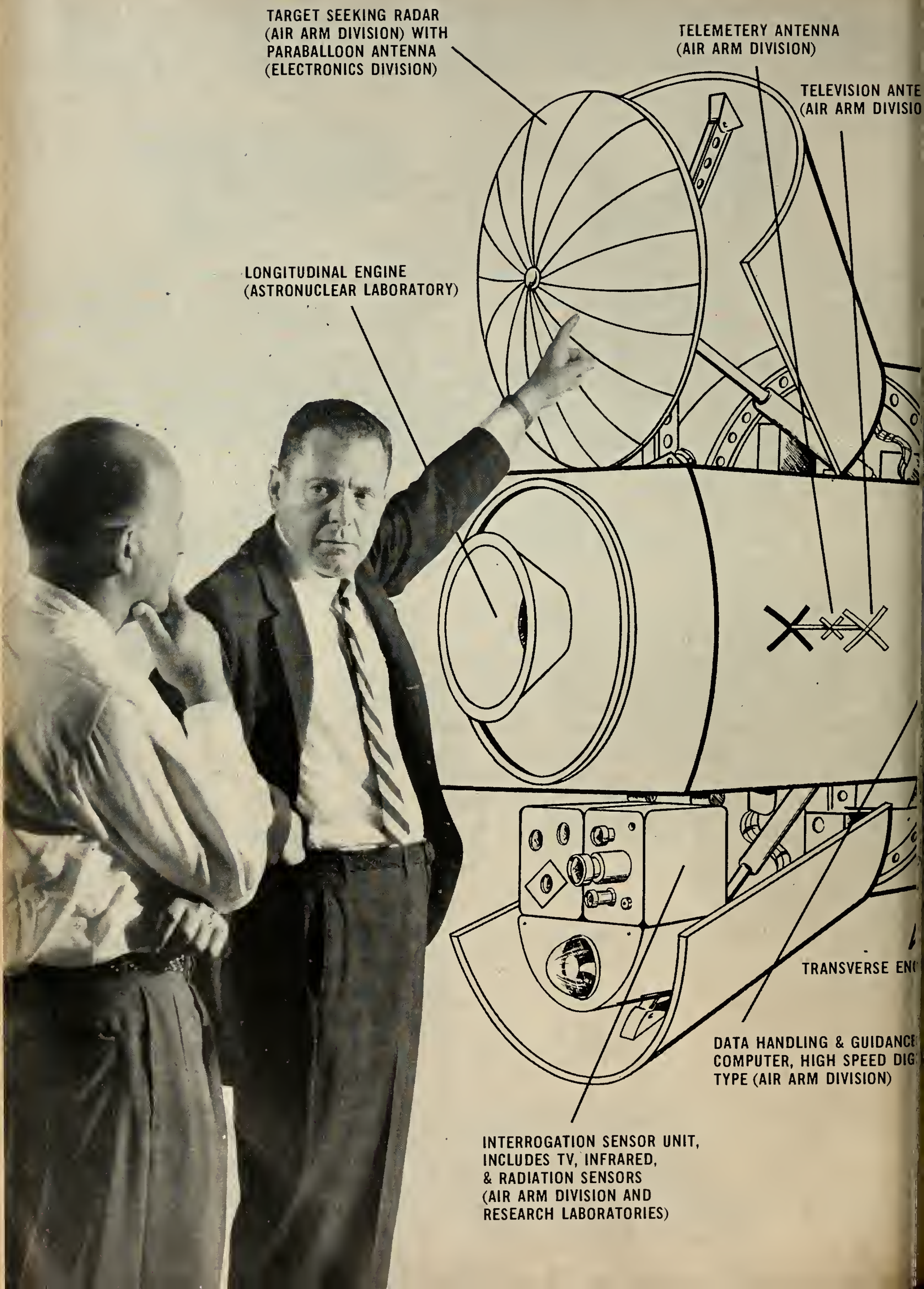
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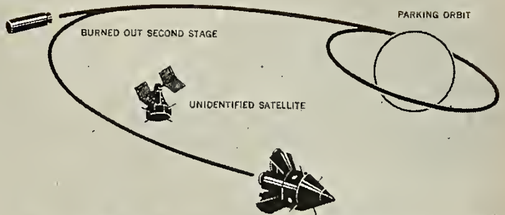

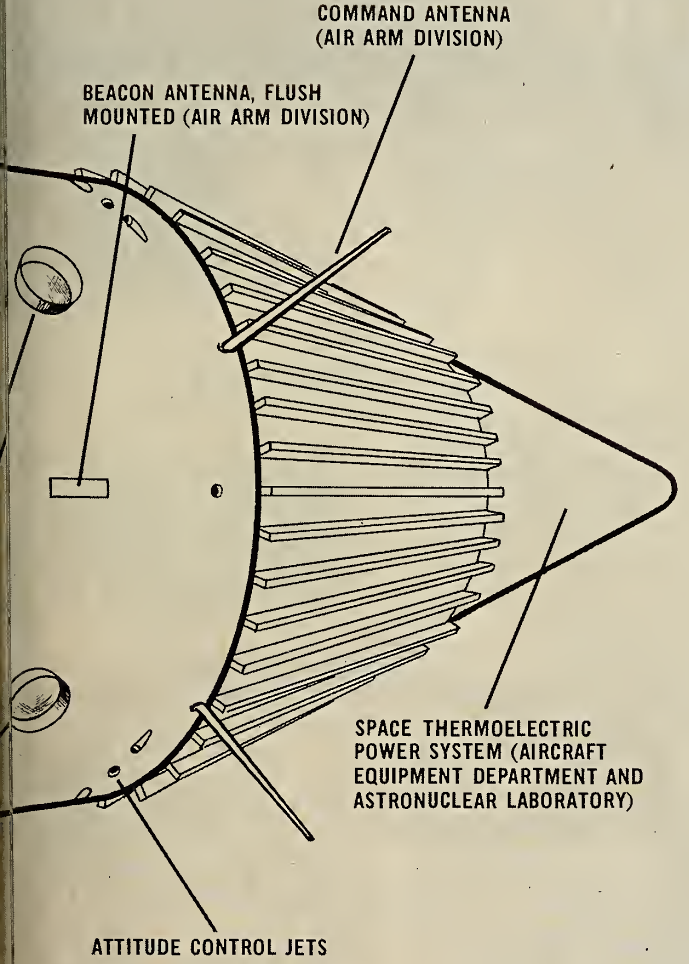
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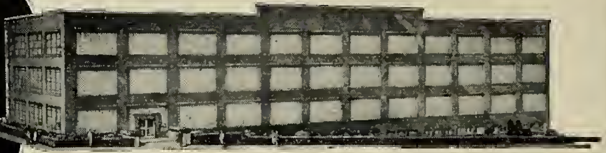

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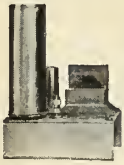

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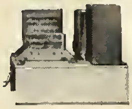
B voltage, 100 to 300 V., at 5 to 10 ma.

ACCESSORY UNITS FOR 2001-2



- L—For low frequencies multi-vibrator type, 40-200 cy.
- D—For low frequencies counter type, 40-200 cy.
- H—For high freqs, up to 30 KC.
- M—Power Amplifier, 2W output.
- P—Power supply.

PRECISION FREQUENCY STANDARDS

TYPE 2005A

Size 8" x 8" x 7¼" High
Weight, 14 lbs.

Frequencies:
50 to 400 cycles (Specify)

Accuracy:
±.001% from 20° to 30°C

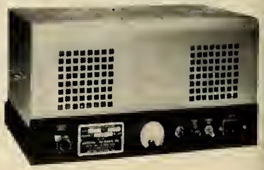
Output, 10 Watts at 115V
Input, 115V. (50 to 400 cy.)

TYPE 2121A

Size
8¾" x 19" panel
Weight, 25 lbs.

Output: 115V
60 cycles, 10 Watt
Accuracy:
±.001% 20° to 30°C
Input,
115V (50 to 400 cy.)

TYPE 2111C



Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.

Frequencies: 50 to 1000 cy.
Accuracy:
(±.002% at 15° to 35°C)
Output: 115V, 75W.
Input: 115V, 50 to 75 cy.

WHEN REQUESTING INFORMATION, PLEASE SPECIFY TYPE NUMBER

ATP
American Time Products
Inc.
61-20 Woodside Avenue
Woodside 77, N. Y.

Vibration recordings . . .

Tape Speeds H-1 Parts Development

Canoga Park, Calif.—Tape recordings of full-scale firings of the H-1 engine that forms the *Saturn* cluster are being used for literal "shake downs" of the engine's components.

The unique system was developed by North American Aviation's Rocketdyne Division to reduce time and expense in component development.

To obtain basic data for the system, the component to be tested is drilled and tapped in all three axes (X-Y-Z). Gulton crystal accelerometers are then fitted to the drilled holes. Outputs from the accelerometers supply inputs to a modified Ampex 350 recorder. This setup furnishes complete recordings of the vibration environment to which the part is subject at all phases of the engine's operation.

In another version of the same system, vibration data during actual liftoff of *Jupiter* and *Thor* missiles have been recorded by means of a supplemental telemetry link.

Recordings are made at 60 inches per second. Six channels per component are available, plus one time channel. In some tests, as many as 24 channels have been used.

Taped data is then analyzed to determine the most critical vibration parameter for the component being tested. The original recording is usually transferred from the wide instrumentation tape to standard ¼-in tape.

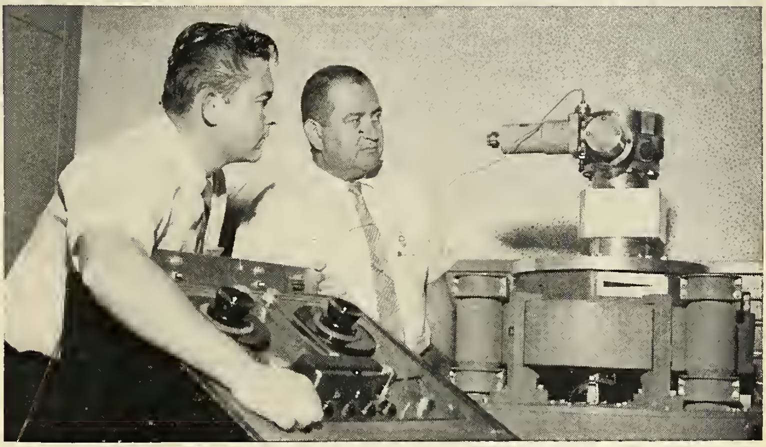
Once the critical vibration regime has been determined, the tape is made into a short loop which repeats the environmental data for a four-second period. For playback, the tape is normally limited to a single; or "worst," channel selected from the original engine recording.

The exact range of interest may vary considerably, depending upon the component and the component's reaction at various frequencies. In general, most of the Rocketdyne tests have fallen within the range of from 20 cps to 2000 cps and with varying intensity.

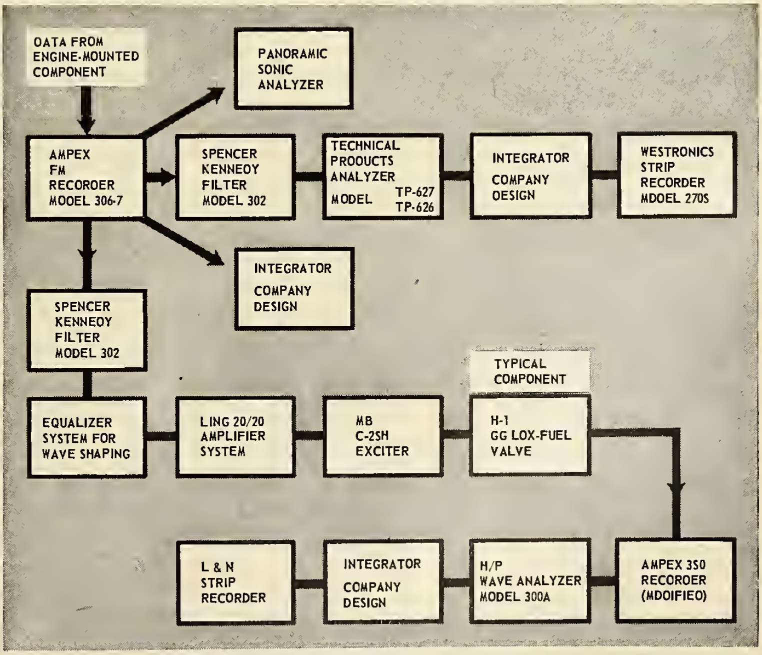
Playback of the tape on an Ampex FM recorder Model 306-7 is fed through a Rocketdyne-designed system to a shaker table. To back up the test, a Westronics strip recorder monitors input frequencies and an Ampex 350 is again used to record data from the component on the shaker table. Further backup is provided by a strip recorder as shown in the accompanying system diagram.

• **Multiple testing**—Where the concept pays off, according to the system's designers, Jud Ferentz, a Rocketdyne senior stress engineer, and Wayne Perkins, instrumentation engineer, is that components may be tested as many times as necessary to develop the required performance and reliability. In addition, vibration factors may be amplified to greatly exceed those encountered in actual engine runs to enable study of hardware moment in axes with larger excursions.

Specific H-1 engine components tested with the tape technique include the main fuel valve, gas generator control valve assembly, main LOX valve and the fuel additive blender unit.

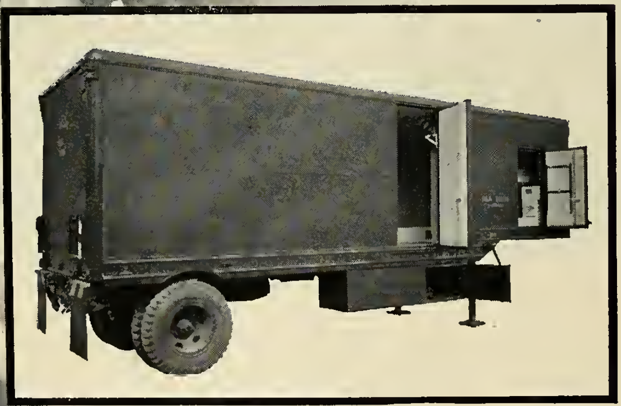


H-1 ENGINE component is checked out by Rocketdyne engineers Wayne Perkins (left) and Jud Ferentz. Tape-fed shaker table duplicates operational environment.


DATA FROM ENGINE-MOUNTED COMPONENT
PANORAMIC SONIC ANALYZER
AMPEX FM RECORDER MODEL 306-7
SPENCER KENNEDY FILTER MODEL 302
TECHNICAL PRODUCTS ANALYZER MODEL TP-627 TP-626
INTEGRATOR COMPANY DESIGN
WESTRONICS STRIP RECORDER MODEL 270S
INTEGRATOR COMPANY DESIGN
SPENCER KENNEDY FILTER MODEL 302
TYPICAL COMPONENT
EQUALIZER SYSTEM FOR WAVE SHAPING
LING 20/20 AMPLIFIER SYSTEM
MB C-2SH EXCITER
H-1 GG LOX-FUEL VALVE
L & N STRIP RECORDER
INTEGRATOR COMPANY DESIGN
H/P WAVE ANALYZER MODEL 300A
AMPEX 350 RECORDER (MODIFIED)

SCHEMA OF ROCKETDYNE'S tape system for testing Saturn H-1 engines.

business office for the Jupiter



...Completely air-conditioned, heated and insulated according to U. S. Army Ordnance specifications, this semi-trailer van houses crew and electronic equipment required for field operation of the Jupiter surface-to-surface missile. This is just one of the special equipment ground support vehicles designed and built in collaboration with the Detroit and Redstone Arsenals by Lyncoach, manufacturers of specialized mobile units for ground support equipment and custom-built coach and truck bodies.

Complete Research & Development facilities available. Contact:

LYNCOACH & TRUCK CO., INC.

443 Chestnut Street *Oneonta, N. Y.*
Phone: GEneral 2-2900 *TWX: ONEONTA NY 8014*

Other Lyncoach-built semi-trailer units—
Triple launch control for Jupiter Missile
Planetary van for Redstone Missile
Guidance and control for Redstone Missile
1 ton ground support equipment trailer chassis for Hawk Missile

NTDS Described

Navy's New System Is Big Tactical Advance

THE NAVY IS TAKING some of the wraps off its new tactical data system designed to permit a task force to operate "almost as one ship" to defeat enemy aircraft/missile attacks.

Called NTDS (Naval Tactical Data System), the computer system automates the collection, display, and dissemination of combat information. Computers aboard deployed units of the task force exchange information which, added to memory-held data, provides complete knowledge of an overall tactical situation. Practically zero-time information interchange and evaluation makes it possible for all units to coordinate operations.

The system correlates all data into a clear picture of the tactical situation, processes data required for making decisions, and communicates action decisions to selected weapons systems. By contrast, conventional grease-pencil or voice-telling techniques communicate the tactical picture too late for offensive and defensive action against new high-speed weapon systems.

The Navy describes NTDS as a gigantic step forward in tactical combat direction—comparable to the transition from sail to nuclear propulsion.

• **Human burden relieved**—NTDS works at fantastic speeds. Action information coming from radars, sonars, radio, IFF, ECM systems, and human sources goes into shipboard data-processing equipment. Here such functions as identity, size, location, detection, tracking, and speed of friendly and enemy vehicles are worked out in transistorized Univac computers that form the "brain" of the system.

The Navy says the NTDS coordination of data will go far to eliminate problems arising from human relay of information. Much of the tiring, repetitive routine will be lifted from operating as well as command echelons, allowing more time for judgment and decision.

Heart of the NTDS is the Univac Advanced Navy Computer (AN/USQ-20). The entire computer measures only 3 x 3 x 6 feet and contains 3776 identically packaged electronic circuit modules.

It is a general-purpose, stored-program machine with a very high-speed, random-access memory containing 1,000,000 bits of information. Thirty bits, comprising a single word, may be extracted from any location in the memory in only 2.5 millionths of a second.

The computer solves a given problem by executing instructions stored in

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He's got Minutemen "working on the railroad"

Hard basing is one way to protect America's force of retaliatory ICBM's. The problem was to find an alternate means of accomplishing the same mission. The Air Force solution was a new ICBM mobility concept—railroad car-mounted Minutemen, utilizing the nation's vast track mileage for numerical and geographical dispersion, creating a difficult target for enemy attack.

To put the Minuteman, its support systems and associated equipment on rails was a completely new problem in missile handling. The first requirement assigned by Boeing to American Machine & Foundry Company and ACF Industries, Inc., was a feasibility study of the existing limitations of roadbeds, rails, railroad operations and right-of-way. Unique tactical cars are being designed within these limitations to carry the Minuteman—cars that can handle the missile and its operating equipment, safely isolated from roadbed shock and ready for immediate retaliatory launching.

Single Command Concept

Whether for conceptual problems such as this one, or for challenges in design or manufacturing, AMF has ingenuity you can use. AMF people are organized in a single operational unit offering a wide range of engineering and production capability. Its purpose—to accept assignments at any stage from concept through development, to production, and service training...and to complete them faster in

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- *Weapon Systems*
- *Undersea Warfare*
- *Radar*
- *Automatic Handling & Processing*
- *Range Instrumentation*
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- *Nuclear Research & Development*

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AMF Building, 261 Madison Avenue,
New York 16, N. Y.

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AMERICAN MACHINE & FOUNDRY COMPANY

NOW FROM JOHNS-MANVILLE:

THERMOMAT®...a new non-woven asbestos molding compound in sheet form!

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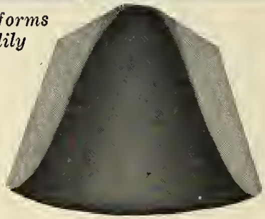
Conforms readily



Machines cleanly

J-M THERMOMAT creates components and parts that withstand tremendous heat and pressure . . . offer maximum resistance to flame erosion.

Here's a new development from the Johns-Manville Research Center! A conformable new asbestos molding material which, in final form, meets the extreme demands of rocket and missile applications. Thermomat is a tough, pliable asbestos felt sheet, saturated with phenolic resin.

Thermomat has proved its dependability as a flame shield . . . as a rocket motor liner inside the metal casing of a solid fuel combustion chamber . . . and in nose-cone applications. Project engineers working on a missile project found that when used in a ⅛-inch thickness, Thermomat protected the metal casing of a solid fuel combustion chamber operating at 5000 F for about 90 seconds, in areas where no flame erosion occurred. Asbestos is the "magic mineral" that contributes greatly to Thermomat's exceptional ability to withstand extreme temperatures . . . and resistance to abrasion and erosion during the ablation process.

MOLDERS like to work with Thermomat because it is in sheet form and handles so well. Fibers are free-flowing during molding; joints and seams work readily together, like putty. Thermomat's remarkable draping ability saves many hours of lay-up time. Even in intricate molding, non-fillouts are reduced to a minimum, and parts machine well after molding.

Same material can be molded at low pressures as well as at extremely high pressures. It is supplied in sheets 14" wide...approximately 12' long...and 3/16" thick. Molders are invited to write for samples of this remarkable material. Write to Johns-Manville, Box 14, New York 16, N.Y. In Canada: Port Credit, Ontario.

JOHNS-MANVILLE
THERMOMAT

JOHNS-MANVILLE
JM
PRODUCTS

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its memory. The instruction list consists of 64 operations which the computer is capable of performing.

- **Small but fast**—A list of instructions, called a program, using combinations of the basic 64 computer instructions, controls machine operation. The machine's ability to complete an instruction in only 20 millionths of a second—or 50,000 instructions in a single second—is an indication of its great speed.

New design concepts and the use of transistor-diode circuitry, rather than the conventional vacuum tubes, account for the computer's small physical size. Although it occupies only about nine sq. ft. of floor space, the computer does the work of two Univac 1103 computers, each of which occupies about 1400 sq. ft. of floor space. Power consumption is 2.5 kw.

Overall system responsibility and operational concept and guidance for NTDS rested with the Chief of Naval Operations. The Bureau of Ships, aided by the Navy Electronics Laboratory, has been responsible for system technical-design contract administration and hardware implementation. Hardware was developed and built by various contractors—Remington Rand Univac, Hughes Aircraft Co. and Collins Radio Co.—and the system complex assembled by NEL.

STL Study Aims at Better Batteries for Spaceships

A limited test program being conducted by Space Technology Laboratories under an NASA contract should aid the nation's battery manufacturers to properly direct their development efforts.

STL is seeking to determine the mode of failure of the *Pioneer V* batteries and to determine performance imitations of presently available storage cells for use in space vehicles.

STL, answering an inquiry by M/R, aid there are three areas in which extensive effort is required to obtain reliable, long-life, sealed storage batteries n the immediate future.

First, extensive testing must be accomplished to predict performance haracteristics.

Second, critical analyses of cell ailures are required to explicitly determine failure modes and areas in vhich R&D are required.

Third, after determining the limits f performance capabilities in the pace environment and the modes in vhich the capabilities are limited, funds nust be appropriated to enable battery nanufacturers to conduct R&D programs to improve electrochemical and nanufacturing processes.

The first warning alerted posts all over the United States and Canada. Unidentified airborne objects seemed to be approaching at supersonic speeds from many directions. ¶ Simultaneously in control centers throughout North America men and machines dealt with torrents of data. Watching blips on radar scopes, crews made decisions which ordered weapons to destroy the attackers. Interceptor pilots reported over loudspeakers. As the enemy reacted and shifted, fresh instructions crackled through command phones. ¶ But no rockets were fired. No bombs fell. The blips came from magnetic tapes made by a single high-speed computer. Called Operation Desk Top, this was a simulated raid—the most gigantic ever arranged—to exercise the North American Air Defense System. In planning it, SDC made four billion calculations and six and one-third miles of magnetic tape. ¶ To train managers in decision-making, to exercise decision-makers under realistic stress, to avoid costly errors in actual operations—these are some of the purposes of SDC's pioneering work in systems research and development. ¶ **SYSTEM DEVELOPMENT CORPORATION.** A non-profit scientific organization developing large-scale computer-based command and control systems. Staff openings at Lodi, New Jersey and Santa Monica, Calif.

SDC

THE IMITATION REAL THING

11-157B

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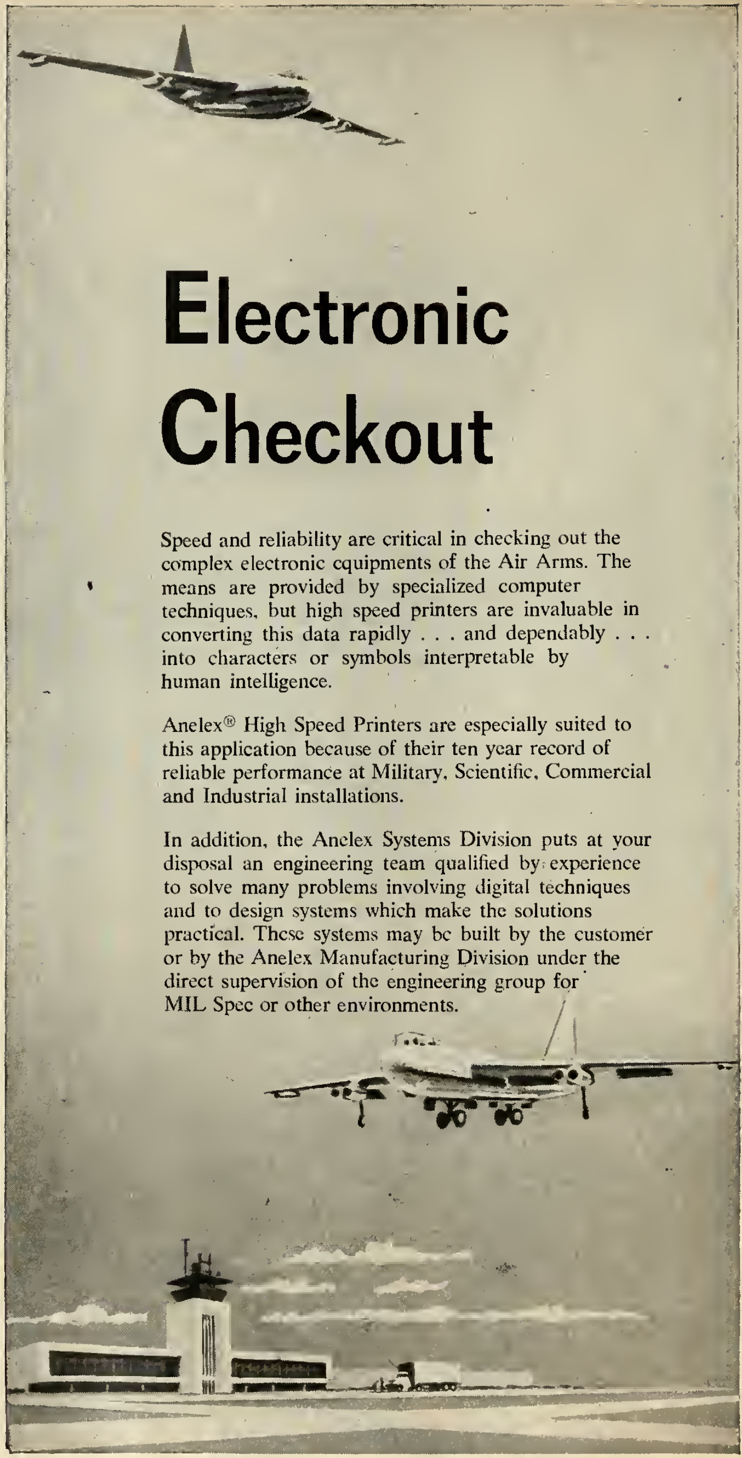

Electronic Checkout

Speed and reliability are critical in checking out the complex electronic equipments of the Air Arms. The means are provided by specialized computer techniques, but high speed printers are invaluable in converting this data rapidly . . . and dependably . . . into characters or symbols interpretable by human intelligence.

Anelex® High Speed Printers are especially suited to this application because of their ten year record of reliable performance at Military, Scientific, Commercial and Industrial installations.

In addition, the Anelex Systems Division puts at your disposal an engineering team qualified by experience to solve many problems involving digital techniques and to design systems which make the solutions practical. These systems may be built by the customer or by the Anelex Manufacturing Division under the direct supervision of the engineering group for MIL Spec or other environments.

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Aerodynamic Re-entry Form Favored by NASA, Soviets

Scientists on both sides of the Iron Curtain declared last week that an aerodynamic shape like *Dyna-Soar* is better than a ballistic shape like the *Mercury* capsule for re-entry from orbit or deep space.

The reports come from Inna Yavorskaya, scientific secretary of the Interplanetary Travel Committtee, Soviet Academy of Science, and from Thomas II. Wong and Robert E. Slye of the Ames Research Center of the National Aeronautics and Space Administration.

Miss Yavorskaya made her statement in an article, "Man Will Fly into Space," submitted to the American press through the Soviet Embassy in Washington.

Recalling that air drag acting on a fast-flying object generates vast amounts of heat, she said:

"This makes it essential to slow down the speed of re-entry by aerodynamic means. The testing of new ballistic missiles in the Pacific last January was of great interest from this point of view. The dummy final stages of the rockets had been protected from heating by a special technique and landed intact in the prearranged area."

Miss Yavorskaya gave no indication of the special technique used for heat protection.

Wong and Slye made their comment in a NASA technical report, "The Effect of Lift on Entry Corridor Depth and Guidance Requirements for the Return Lunar Flight."

- **Rations**—The use of lift in amounts producing relatively small lift-drag ratios increases the usable depth of the entrance corridor, they found.

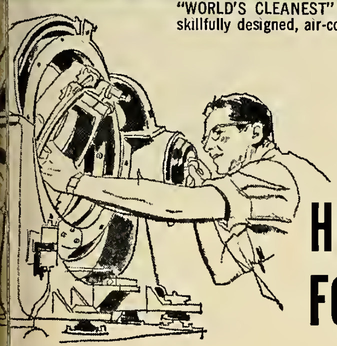
If maximum decelerations are limited to 10 g, they said, the corridor depth increases from 8 miles for a ballistic vehicle to 44 miles for a vehicle with L/d of 0.47. If 20-g deceleration is allowable, the depth increases from 22 miles for a ballistic vehicle to 104 miles for one with L/d of 0.84.

If higher lift-drag ratios are used, the corridor depth increases—but so does maximum deceleration.

Miss Yavorskaya outlined three major possible methods of solving the re-entry problem. Firing of retro-rockets is very dependable, she said, but the necessity of carrying a big fuel supply into orbit puts the retro-rocket "outside the bounds of feasibility for the time being."

Use of air drag for braking, she declared, does not guarantee an adequate landing accuracy.

"WORLD'S CLEANEST" ASSEMBLY ROOM. This 55-station facility is so skillfully designed, air-conditioned, and filtered that 99.95% of all contamination bigger than 1 micron (.000005") is removed. The result: perfect conditions for mass assembly of delicately precise components.



Knowmanship in Action:

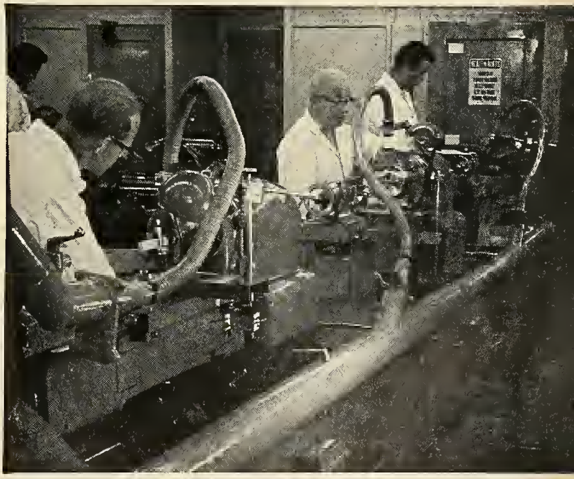
HOW UNIFIED E-P FACILITIES MASS-PRODUCE FOR PRECISION NEEDS OF THE AERO/SPACE AGE

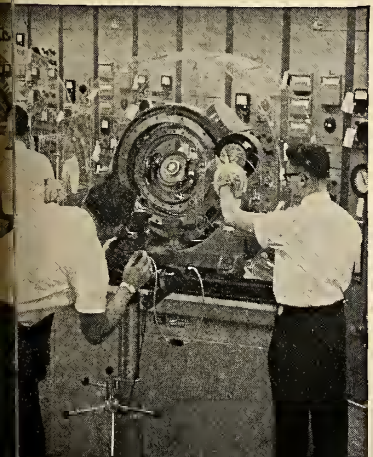
Iany of the aero/space age's most precise components are being nass-produced today at Eclipse-Pioneer. An example: inertial uidance systems for second-generation missiles . . . a true test –and proof—of E-P Knowmanship in action.

ur mass-production complex is completely self-contained and nified. Here, in an atmosphere of ultra-cleanliness, precision omponents are assembled, tested, checked, calibrated and tored under the exacting demands of superfine quality control.

ar more than a prototype, this aero/space-age facility is a going oncern, ready to go to work on *your* problems. Benefit from clipse-Pioneer's Knowmanship, developed through 40 years' lose association with the aero/space industry. Write today—escribe your problems—utilize our capabilities.

TECHNICAL KNOWLEDGE + EXPERIENCED MANAGEMENT + SPECIALIZED CRAFTSMANSHIP = **KNOWMANSHIP**





← SUPERFINE TEST AND CALIBRATION. E-P checkout facilities include: Single axis and planetary sidereal test stands accurate to .005° per hour; indexing heads with an accuracy of ± 2 seconds of arc used for calibrating pendulous integrating gyros; turn-tilt stands positionable to ±5 seconds of arc; and ball disc integrator test stands accurate to .0025%. Calibration equipment was bench-mark-positioned by certified geodetic survey.

↑ BERYLLIUM—SPACE-AGE METAL. Here, in a completely enclosed, temperature-controlled room, highly skilled E-P machinists work with beryllium. Parts such as gyro components for missiles are produced to tolerances of ± 10 millionths of an inch. For the exacting demands of this kind of production, entirely new concepts in machining, quality controls and safety engineering were developed by Eclipse-Pioneer.

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Circle No. 25 on Subscriber Service Card.

By DOD advisory group . . .

Drastic Changes in Parts Specs Urged

Proposed management methods—if adopted—would have top-to-bottom effect on government and industry

by Donald E. Perry

Three years ago, a Pentagon advisory group recommended that some bold steps be taken in the management of electronics parts specifications to insure reliability.

Now something is finally being done about it: another group has made more recommendations.

It appears, however, that the new proposals will have a major impact on both government and industry, from management down. Will have, that is, if they're adopted; many of the suggested procedures are radical departures from established methods.

This month, in any case, a program to implement the new recommendations will be submitted to Dr. Herbert F. York, Director of Defense Research and Engineering, and Perkins McGuire, Assistant Secretary of Defense (Supply and Logistics).

• **Background**—In June, 1957, Task Group 5 of the Advisory Group on Reliability of Electronic Equipment reported that the fast-changing state of the electronics art required:

–More electronic parts and tube specifications.

–Faster coordination of specs.

–More dissemination of technical characteristics data to design and logistics personnel.

–Complete review of parts specifications, to provide both compatibility and reliability.

Thirteen months later, an Ad Hoc Study Group on Parts Specifications Management for Reliability was established under the sponsorship of York's and McGuire's offices.

Under the chairmanship of Paul S. Darnell, of Bell Telephone Laboratories, the study group has now come up with specific recommendations. It has mailed to industry a two-part, 235-page report which details an organization structure and establishes three prototype specifications, together with new procedures for refining the technical documentation of parts characteristics.

• **Indictments**—The report criticizes "unsuitable and inadequate" specification organization and management on the part of DOD and the military services. It makes these points:

–Trouble stems primarily from management and organization—only secondarily from technical inadequacies.

–The services have regarded parts specifications and standardization programs only as "part-time" efforts, and have not given them the attention they deserve in view of their huge potential for saving dollars and improving equipment reliability.

–There is a tendency to make non-technical people responsible for revising and developing specifications—with the result that practically all specs are out of date in terms of industry know-how.

–Some management has been "totally unable" to cope with the simple problem that arises when an individual in one of the services will not agree with certain words in a spec suggested by someone in another service. "Because he will not agree," the study group said, "and because there is no suitable procedure for reconciliation, coordination cannot be completed and the disapproving military service is accused of non-cooperation."

The report emphasized that the need for suitable specifications management is the most serious problem in the military parts picture.

"A major overhaul in the present system of specification preparation and administration and the injection of some radical new concepts in specification structure, objectives and requirements are long overdue," it declared.

• **Recommendations**—The study

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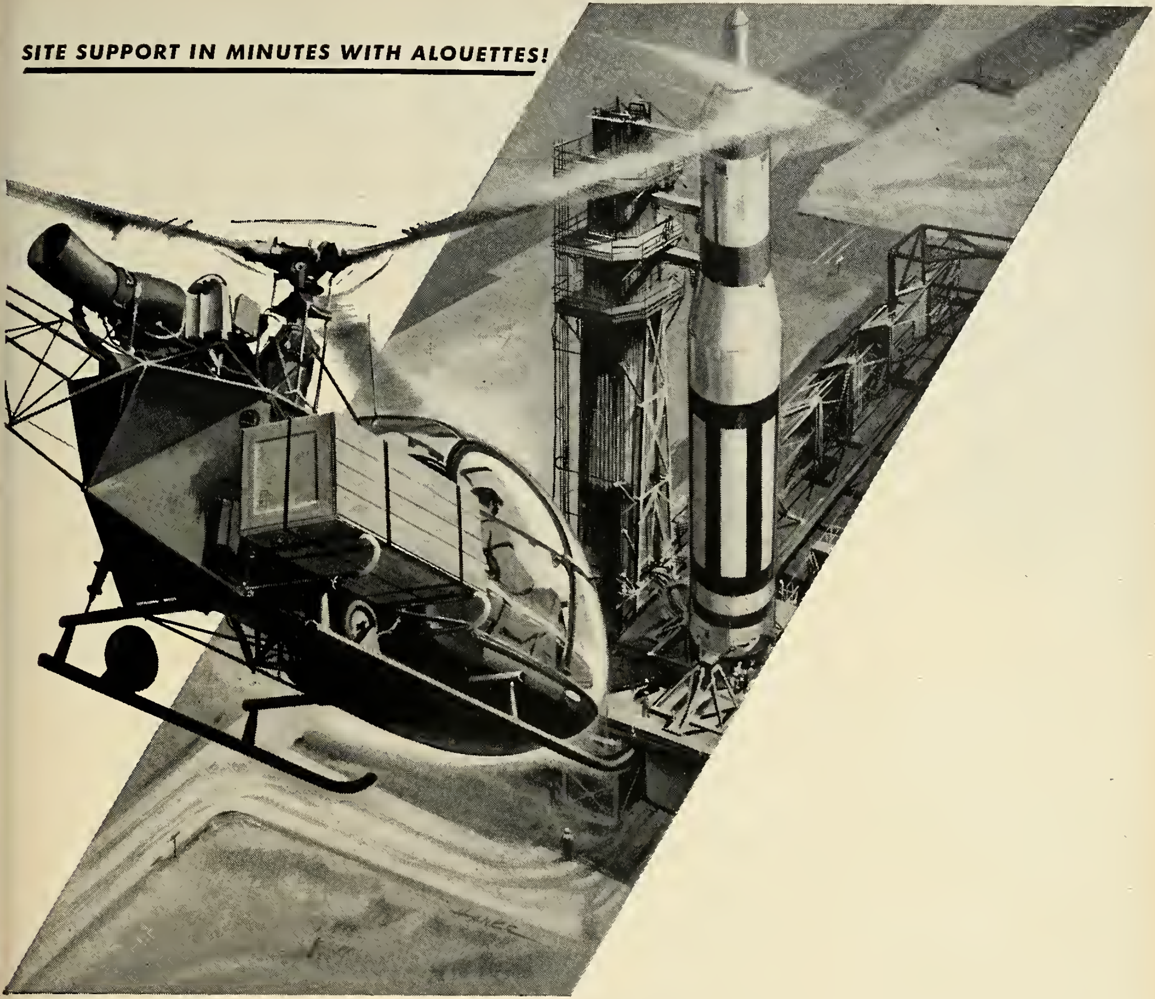
SITE SUPPORT IN MINUTES WITH ALOUETTES!



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AND THE "MINUTES PHILOSOPHY"

Our defense and offense complex must function in a matter of minutes. Reliable missile site support in "minutes" can be maintained by instant-starting, jet-powered Alouette* helicopters, world's only time-proven turbine copter. An Alouette Site Support Program is immediately available to the military—with tested reliability, and low maintenance and operational costs — at ONE-HALF THE COST of comparable programs.

The Alouette MEANS reliability, ease of maintenance and minimum operational budgets with the advantages of turbine power.

*Designed by Sud Aviation

REPUBLIC AVIATION CORPORATION

HELICOPTER DIVISION

FARMINGDALE, LONG ISLAND, N. Y.

actual size

BRISTOL chopper helps put Navy TARTAR on target

. . . Every component in the U. S. Navy's TARTAR, newest supersonic surface-to-air guided missile must meet the highest standards for statistical reliability.

No exception is the Bristol Syncroverter* chopper used in the TARTAR's guidance system. The TARTAR, produced for the Bureau of Naval Weapons by Convair (Pomona) Division of General Dynamics Corporation, is slated to form the primary antiaircraft weapon aboard destroyers and secondary antiaircraft batteries aboard cruisers.

The Bristol Syncroverter chopper has a long history as a component in U.S. guided missiles. It's the ideal miniature electromechanical chopper for use in d-c analog computers or wherever utmost reliability is required.

BILLIONS OF OPERATIONS have been completed without a failure on Bristol's continuing life tests—aimed at improving the Syncroverter's already superlative characteristics. Just one sample: A group of five choppers, with 400 cps drive and 12v, 1 ma resistive contact load have been going for more than 26,000 hours without failure. That's more than 2.96 years continuous operation or more than 37 billion complete cycles!

No matter what your chopper requirements, we're sure you can find the model you need among the wide selection of Syncroverter choppers and high-speed relays available . . . including low-noise, external coil types. For complete data, write: The Bristol Company, Aircraft Equipment Division, 150 Bristol Road, Waterbury 20, Conn. 0.15

*T.M. Reg. U.S. Pat. Off.

BRISTOL FINE PRECISION INSTRUMENTS FOR OVER SEVENTY YEARS

group urged that:

1. An Advisory Group on Management of Electronics Parts Specifications be established as an activity of McGuire's office, reporting directly to him. Members would be appointed by McGuire, with the coordination of York's shop. Members would have both management and technical experience in electronic parts, tubes and semiconductors; the electronic-systems design area; and the engineering, procurement and logistics areas of DOD. All programs on electronic-parts specification development and technical documentation, and their management, would be channeled through the Advisory Group.

2. The Armed Services Electro-Standards Agency be organizationally relocated under McGuire's jurisdiction, providing administrative and secretarial support to the Advisory Group.

3. The office responsible for standardization in OSD (S&L) prepare and recommend DOD policy and plans for implementation of development of specs, standards and handbooks.

4. Parts specifications include some new procedures for accumulation of life-test data, over an extended period of time, from tests carried out in acceptance inspections. Failure rates would be computed from these accumulated data, with the specification establishing several graduated failure-rate levels.

5. The present "Qualified Products Lists" be changed to "Approved Sources of Supply for Qualified Electronics Parts List." Besides submitting qualification test data for initial approval, manufacturers also would have to provide evidence that they have adequate production and test facilities and employ sound procedures for process and quality control.

Specifications would also provide for separate identification of items having different established failure-rate levels by using different part numbers. The manufacturer also would be required to assure continued conformity with the specification through routine submission of test data collected during acceptance inspection.

6. All parts specifications require the manufacturers to provide test data on the parts supplied.

7. DOD issue a single new policy manual to standardize design and procurement documentation for military components.

8. Use of contractor's specifications be reduced by upgrading existing military specifications with respect to environmental requirements.

9. Contractors and the military departments insist that all specification test requirements be carried out by the parts manufacturers prior to shipment of the parts.

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Welding Method Joins Thin, Thick Metal Parts

A new method of resistance welding which permits joining of ultrathin materials to thick plates has been developed at the Ryan Aeronautical Co.

The company says the method is particularly suited to welding thin sheet metal of a few-thousandths of an inch thick (up to .016 in.) to plates whose thickness ratio exceeds four to one, or any thin metals to thick in parts for Space Age rockets and missiles.

The new system is said to produce a uniformly accurate and securely bonded structure. Conventional resistance welding frequently results in the weld nugget forming within the thick material instead of equally at the interface. This is not true of the Ryan method.

In this type of welding, an electrode is applied under heavy unit pressure at the spot to be welded; a heavy pulse of current is supplied to the electrode and the electrode contact pressure is continued until the weld nugget cools.

Welding apparatus for the new method is relatively simple, consisting of a power supply, timing mechanism and a pressure system.

The power source is connected to opposite ends of the primary winding of a transformer; one function of the timer is to control discharge through the winding. The secondary winding of the transformer is connected to one end of the welding electrode. The other end is either grounded to the welding table or attached to the thicker of the two materials being joined.

When the current is released through the primary winding, it causes a pulse of welding current to flow in the secondary winding. The transformer thus sends a heavy current flow at low voltage through the welding electrode. Ryan says a current of about 40,000 amps. at two volts has been used satisfactorily.

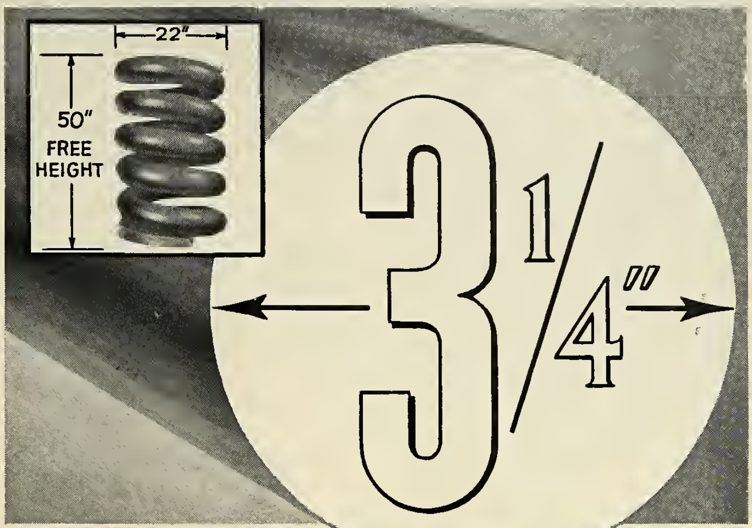
• **Pressurization critical**—Although a wheel-type electrode is said to be ideally suited for use in the process, other types can be used if pressure is accurately controlled. Pressurized to hold the materials together at the point of weld, the wheel rolls along the surface of the thin material to produce a row of space spotwelds.

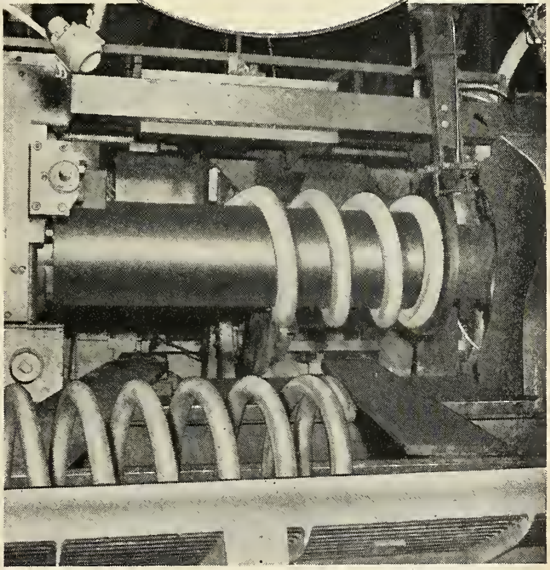
The timer controls both power and pressure application, with timing varying according to materials used and type of welding performed.

Critical factor is the surface resistance at the interface. Since the surface finish of thin sheet metal is generally smooth, the interface resistance

ONLY ASF HAS IT!

New machine coils 3 1/4″ bar stock into 22″ diameter springs for missile silos





Automatic operation assures unprecedented product uniformity

Springs Pass Air Force Inspection

Quality production of the heaviest heavy-duty springs at ASF—HAMMOND Division took another giant step forward recently with the installation of this specially designed machine. It coils 3 1/4″ bar stock into half ton springs with 50″ free height. These springs are uniform in all essential physical characteristics.

This new machine automatically controls coiling time to minimize loss of temperature, which assures effective hardening. This results in new standards of uniformity in the heavier springs. If you have a shock-mitigation problem, why not write today for complete information.

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HAMMOND DIVISION Hammond, Indiana

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NOT THE SIZE OF THE JOB but the demand for positioning accuracy determines the need for BEAVER BALL SCREWS

Raytheon uses this Beaver Ball Screw in the "Hustler" search radar to actuate a delicate and extremely precise instrument control — everything else is classified, except that you can hold it between two fingers!

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can be made nearly constant by careful control of electrode pressure.

Greatest heat build-up is at the interface, which provides virtually the entire resistance to the welding current. For this reason, the weld nugget forms equally at the contacting faces of the materials.

Accurate control of pressure after welding is necessary to prevent cracking and expulsion of the foil gages. With a wheel electrode advancing 15 inches per minute, making 10 welds per inch, it was found that electrode pressure was maintained long enough to avoid cavitation.

Experiments indicated that with types of welding requiring longer weld periods, excess heat generated in the weld area resulted in such slow cooling that it was impractical to maintain the required follow-up pressure.

The new method was developed by Ryan welding engineers John R. Fullerton, Laurence E. Leech and Donald L. Heyser. They have applied for patents, assigning the rights to Ryan.

Ion Engines May Utilize Water-Permeable Tungsten

In the production of controlled density tungsten, Firth Sterling Inc. has come up with an interesting by-product—truly porous tungsten.

The company has been working with fully sintered tungsten bodies, varying in density from 50% of theoretical to 95% of theoretical. The techniques involved are being utilized to produce permeable tungsten with theoretical densities from 50% to 75%.

Although parts are being fabricated, physical and mechanical data for all the densities have not yet been determined. At 55% theoretical density, the material shows room-temperature properties including cross break at 4500 psi, tensile strength of 7500 psi (Armour Institute ring tensile method) and thermal shock resistance up to 3200°F with indications that the erosion resistance should be good.

The tungsten is permeable to water at atmospheric pressure.

Such tungsten can be used for rocket nozzle inserts, either impregnated with a plastic which will decompose upon heating to liberate a cooling gas such as hydrogen, or as part of a liquid-cooled assembly where the metal may be used as a throat insert for releasing coolant into gas stream, or as a reservoir for the coolant.

Electronics offers other possibilities. The tungsten may be utilized in emitter tubes and electron tubes.

Plasma and ion propulsion devices may create other applications, such as porous discs in ion engines and circulation-cooled nozzle components.

3M Materials Memo

News of materials for the aerospace industry—selected from the 27,000 products of the 3M Company

Throw The Book At You?

Not this one! But we'll be happy to send you a copy if electrical casting resins are your diet. This particular book is actually a brand new reference manual on 3M's series of "Scotchcast" Electrical Resins. Its proud parent, our ELECTRICAL PRODUCTS DIVISION, would throw up its collective hands in horror at the mere thought of its being even considered a catalog. They've gone all out to insure that this manual will be an equally useful tool for old pro and tyro alike.

You'll find within the 28 pages heavy emphasis on techniques and tips for using casting resins. These cover such aspects as component design, molds and mold releases, resin storage and application, special equipment and all sorts of other "pointers for potters." Then there's the guide to selecting the proper resins for given electrical applications. Beefing it up still further are tables of physical and electrical property data on the "Scotchcast" family of resins.

This book's a real collector's item. Why not cast off your electrical insulation problems by getting your own copy? Just check the box below.

Caged Radiation

If you've been anxious to put radioactive isotopes to work *for* you, but have been afraid they may end up working *on* you, this will be a welcome bit of news. These hot little personalities have been tamed in a way that makes them even more useful and yet substantially reduces the handling hazards. The isotope is literally caged in tiny ceramic beads, approximately 50 microns in diameter. The union between ceramic and isotope is actually a chemical bond which keeps miscellaneous solvents, chemicals, and even the human digestive system from leaching out the radioactive material. Our CENTRAL RESEARCH LABORATORIES have refined the process to such an extent that they can now treat almost any of the radioactive isotopes.

The products, known as Radiating Microspheres, lend themselves well to a variety of industrial and medical applications. Being uniform in particle size, and free flowing, they can readily be incorporated in a variety of products. Their use in detectors for film thicknesses and densities or as tank level indicators is a natural, thanks to their chemical resistant overcoats.

Nor do the possibilities end there. Encased in suitable plastics, the Radiating Microspheres can form self-energized luminous instrument dials, signs, etc. Let our Central Research Laboratories tell you how Radiating Microspheres can brighten your future, too—by checking the box below.

Paper Shufflin'

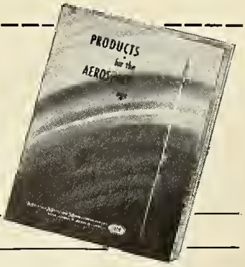
It may seem mundane to talk about paperwork in the highly sophisticated aerospace industry, but correspondence is more than ever becoming the business-man's burden. Indeed, we wonder if a pound of hardware isn't accompanied by a pound of correspondence! There are two bad features about this nightmare of paperwork. One is the time required to handle it and the other is the space required to store it. Our DUPLICATING PRODUCTS DIVISION has come up with two time and space savings ideas to help you solve your paper work problems.

One of these is the fabulous "Filmac" Reader-Printer for reading Microfilm and making instant projection prints. It was described in an earlier issue.

The other is an idea called the Short Note Reply, and sometimes known as the SNR system. It works like this. You get a letter or memo which requires a short reply. Instead of dictating an answer and putting it into the steno pool, you simply write your answer at the bottom of the copy of the letter. A dry copy is then made on a "Thermo-Fax" Copying Machine and returned to the sender. You have the original for your files and he has a copy for his. After you've written your reply, the copying process takes only 4 seconds. For more information on this time saving method of handling correspondence check "Thermo-Fax" Copying Machine on the coupon below.

3M Company, Missile Industry Liaison—Dept. VAB-90
St. Paul 6, Minn.

Please send ☐ reference manual on "Scotchcast" Electrical Resins ☐ information on Radiating Microspheres ☐ facts on "Thermo-Fax" Copying Machine ☐ 3M Products for the Aerospace Age.



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"This missile age of ours requires vast scientific and engineering technology. MISSILES AND ROCKETS keeps us posted in this market that expands daily." D. M. Tenenbaum (left), Mgr., Test Division, Sacramento Plants.

"Technical news developments concerning the industry are a day-to-day occurrence. MISSILES AND ROCKETS keeps us right up to date." Dr. R. H. McFee (right), Dir. of Research, Aerojet-General's Avionics Division.

WHY DO SO MANY KEY PEOPLE AT AEROJET-GENERAL READ MISSILES AND ROCKETS?

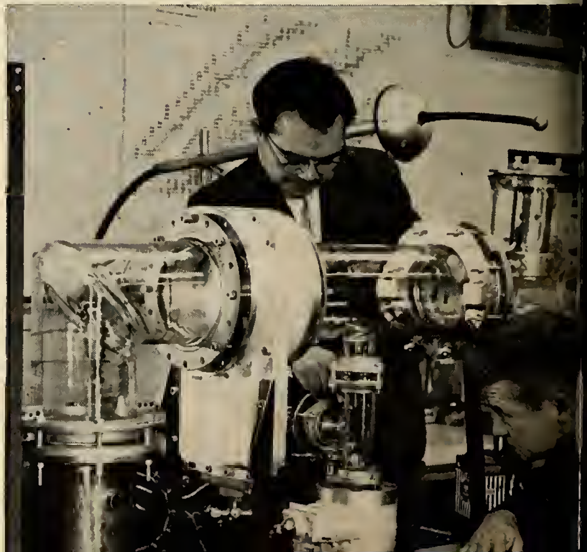
438 PAID SUBSCRIPTIONS! One of the outstanding leaders in the research, design, development, and production of both solid and liquid propellant rocket engines, Aerojet-General ranks 19th among all major defense contractors. Naturally, there are a large number of paid subscribers to MISSILES AND ROCKETS at Aerojet-General—438, to be exact. And since many of the copies have high pass-along readership, there is an even larger number of readers at Aerojet-General.

Some of the many reasons why M/R commands intense readership among key people at Aerojet-General are given in the picture story. They were obtained as a result of a recent visit to the company by M/R Editor Richard Van Osten (insert).

These comments and those of other key readers in other missile/space companies clearly show what M/R has known all along . . . that the missile/space industry is a separate, distinct market with rapidly changing requirements that can best be met by *undiluted, weekly* technical/news coverage. It is this kind of coverage that makes M/R unique . . . explains its deep, penetrating readership and acceptance.

"Today's missile industry evolved from the old concept of the aircraft-missile business but each is now a separate and distinct industry. We read MISSILES AND ROCKETS for that very reason. It deals 100% with Astronautics." M. L. Story, Director, Aerojet-General's Systems Division.

"In this young industry it is absolutely necessary that engineers be filled in on new data as it develops. MISSILES AND ROCKETS provides a complete, clear picture weekly of what's happening in the field of World Astronautics." Dr. G. Moe (left), Aerojet-General's Space Technology Division.



names in the news

Peter Macdonald: Goodyear Aircraft Corp.'s Washington representative for the past five years, named general manager of The Goodyear Tire & Rubber Co.'s Washington office. He succeeds **George M. Riveire,** who has retired.

Dr. E. John Whitmore: Joins Sylvania Electric Products Inc., as manager of development engineering at the Williamsport facilities of the company's Special Tube Operations. Was formerly chief engineer for the Canadian Marconi microwave tube plant.

John E. Peterson: Former associate manager, appointed director of materiel for Space Technology Laboratories, Inc., succeeding **Fran M. Brown,** who has joined the staff of Aerospace Corp.

Thomas T. Witkowski and **John T. Underhill:** Appointed director of Long Range Planning and Operations manager, respectively, for Cubic Corporation. Both were project engineers at Convair prior to joining Cubic in 1956 and 1957.

Dr. George J. Mueller: Named chief of development planning for the Systems Support Dept. of Northrop Corp.'s Nortronics Division. Previous posts: Management consultant on advanced technical programs, American Corporate Services, Inc.; systems technology advisor, Thompson Ramo Wooldridge, Inc.; director of engineering, Packard Bell's Technical Products Division, and technical director, Allen B. Dumont Laboratories.

Edwin A. Speakman: Elected division vice president, Missile Range Programs, for the Government Services Department, RCA Service Co. in charge of RCA's Test Missile Project at Patrick AFB. Prior to joining the firm as manager of planning, Defense Electronic Products, he was vice president of the Fairchild Engine and Airplane Corp. and general manager of Fairchild's Guided Missiles Division.

Dr. Alden Stevenson: Appointed director of research at Pacific Semiconductors, Inc., relieving **Dr. Peterson,** for administrative duties. Dr. Stevenson will also continue as materials research program director.

Col. George Cechmanek (USAF-ret.): Joins Grand Central Rocket Co. as Corporate Counsel. Was most recently assigned to ARDC as chief legal counsel.

James E. Michaels: Appointed supervisor of the Astro Systems Branch, Astro Systems and Research Laboratories at Northrop Corp.'s Norair Division. Previously served with the Space Sciences Laboratory of General Electric's Missile and Space Vehicle Dept. and most recently as project engineer of General Electric-Wright Air Development Division's interplanetary trajectory study.

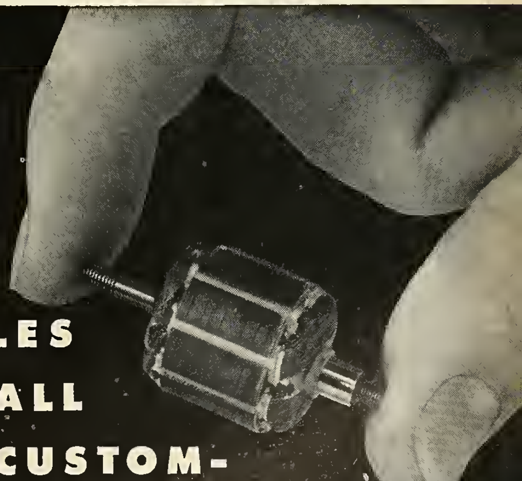
Rear Adm. H. C. Bruton (USN-ret.): Named vice president-planning for the Military Products Division of Hoffman Electronics Corp.

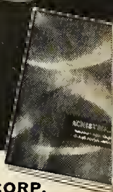
Michael J. Donnelly and **Dr. R. H. Sanders:** Join Controls for Radiation, Inc., as head of the Reactor Chemistry Dept. and senior biologist in the Radiation Biology Dept., respectively.

Davis Factor, Jr.: Former assistant to the president, promoted to director of advertising at Eldon Industries, Inc.

Robert Spies: Former engineering specialist for Sundstrand Turbo, joins the technical staff of Electro-Optical Systems, Inc., as a scientist in the Energy Research Division.

Wilbert W. Toole: Named manager of Electronics and Support Systems in the Customer Service Division of McDonnell Aircraft Corp. Was formerly with Avco





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Corp.'s Crosley Division, responsible for marketing activities.

J. Norman Rossen: Elected director of the Solid Propellant Division of Atlantic Research Corp., succeeding **Presson S. Shane**, elected vice president. Rossen was formerly head of the Rocket Ballistics Group and assistant director of the solid propellant division.

Boyd W. Granger: Joins International Resistance Co., as marketing research manager, succeeding **Martin Zwerin**, promoted to manager of business planning. Granger was formerly Philco Corp.'s Lansdale Division director of market planning.

Rudolph C. Schmidt: Named sales manager of Universal Transistor Products Corp. Was formerly associated with Fairchild Camera & Instrument Corp.

Virgil W. Wall: Appointed director of engineering for Telecomputing Corp.'s Electronic Systems Division, succeeding **Melvin B. Kline**, named to the new position of assistant to the general manager. Wall was previously manager of Raytheon Co.'s Advanced Development Dept.; chief engineer, G. M. Giannini & Co. and radar supervisor, North American Aviation, Inc.

Dr. Lawrence F. Jones: Joins United Aircraft Corp.'s Norden Division as chief-digital group in the engineering department. Was formerly advisory engineer in charge of the digital computer group for Westinghouse Corp.'s Air Arm Division.

J. Bryan Straley: Elected president of Reeves Instrument Corp., a wholly owned subsidiary of Dynamics Corporation of America. Was formerly executive vice president of the firm.

F. Robert Mayer: Joins Amcel Propulsion Inc., as manager of advertising sales promotion. Was formerly responsible for advertising, public relations and sales administration for the Reaction Motors Division of Thiokol Chemical Corp.

Bert J. Gastineau: Former chief Engineer of Aerojet-General Corp.'s Avionics Division, elected manager, succeeding **Richard W. Powell.** Gastineau, who joined the firm in 1952, has been associated with the infrared sight for the F104, *Sparrow II*, *Midas* and other classified projects.

G. William Bauer: Joins Strauffer-Temescal Co. as sales engineer responsible for sales, marketing and customer relations.

Mark W. Bullock: Promoted to vice-president in charge of engineering for Continental Electronics Manufacturing Co., a subsidiary of Ling-Temco Electronics, Inc. Was formerly manager of Continental's production division.

Robert Hansen: Appointed sales and marketing manager for the Electron Division of Controls Company of America.

NEW ERA OF WESTERN DEFENSE

Navy launches first Polaris missile from submerged sub

Erupting from Atlantic waters off Cape Canaveral July 20, a slim white Polaris missile fired from the nuclear submarine U.S.S. George Washington launched a new era of defense. Arching skyward on a column of flame, the Polaris made its clear contribution to the security of free nations before it shook off its last drops of brine. To further demonstrate the missile's dependability, the Navy then launched a second Polaris from the nuclear sub. This was the climax of a remarkable 47-month race to develop the Navy's Fleet Ballistic Missile Weapon System. Combined for the first time were a nuclear-powered submarine, hidden in ocean depths and able to cruise anywhere, unseen for months, and a powerful missile, so compact a single sub can carry 16 of them with nuclear warheads. The Polaris gives America a defense that cannot be overwhelmed by surprise attack, a defense that will work for peace by making aggression unthinkable. Lockheed is prime contractor and missile system manager for the Polaris missile. Aerojet-General Corporation is the subcontractor responsible for the missile's rocket motor, General Electric Corporation for its guidance system, and Westinghouse Electric Corporation for the launch system. The U.S.S. George Washington was built by the Electric Boat Company.

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320	320	5	14 x 10 x 9	349.95	$675-1040
520	520	15	20 x 16 x 10	799.95	$1325-1750
1040	1040	30	24 x 18 x 16	1699.95	$2275-2500
3000	3000	75	31 x 31 x 18	3,999.95	$4450-4900

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contracts

$44,000,000—**Rocketdyne**, Canoga Park, Calif., for development of a 200,200-lb.-thrust hydrogen-fueled rocket engine.

$1,950,000—**Progressive Welder & Machine Co.**, Pontiac, Mich., for engineering, design, fabrication and related services for the manufacture of tooling in connection with various space programs.

NAVY

$8,376,034—**Grumman Aircraft Engineering Corp.**, Bethpage, N.Y., for production of *Eagle* missile airframes, propulsion system launcher and modification of test bed aircraft.

$1,000,000—**Packard Bell Electronics Corp.**, Los Angeles, for production of the AN/ASQ-10 advanced airborne electronics system.

$1,000,000—**Telecomputing Corp.**, Los Angeles, for sonar processing equipment.

$252,000—**Electronic Specialty Co.**, Los Angeles, for timing fuzes for the *Genie*. Subcontract from **Douglas Aircraft.**

$122,588—**The Heil Co.**, Milwaukee, for parts for missile containers (Two contracts).

$80,572—**The Flexible Co.**, Loudonville, Ohio, for frame and lid assembly for missile containers.

MISCELLANEOUS

Instruments for Industry, Inc., Hicksville, N.Y., for developing and manufacturing a missile system gyro test set. Contract from **American Bosch Arma Corp.'s Arma Division.**

$1,165,000—**Specialty Electronics Development Corp.**, Syosset, N.Y., for communication and countermeasure devices and radar test equipment.

$918,000—**William T. Lyons Co., Inc.**, Baltimore, for construction of a complex of buildings, test cells and associated facilities to house a hypersonic propulsion research laboratory. Contract from **Applied Physics Laboratory of The John Hopkins University.**

ARMY

$2,400,000—**Sylvania's Waltham Laboratories**, for development, fabrication and installation of two 60-foot ground antenna systems for *Advent*.

$276,741—**Martin Construction Co.**, Cocoa Beach, Fla., for construction of a *Minuteman* firing tube in two existing concrete silo caissons at Cape Canaveral.

$76,000—**North American Aviation, Inc.**, Columbus, Ohio, for testing a revolutionary concept in antitank missiles.

AIR FORCE

Controls for Radiation, Inc., Cambridge, Mass., for installation, calibration, maintenance and performance of all nuclear radiation protection services at Hanscom Field. Amount not disclosed.

The Rucker Co., Oakland, Calif., for hydraulic and pneumatic power and control equipment for three *Titan* missile launching sites at Larson AFB. Amount not disclosed.

The Garrett Corp.'s AiResearch Manufacturing Division, Phoenix, for applied research on advanced solar space power heat. Amount not disclosed.

$1,000,000—**General Bronze Corp.**, Garden City, N.Y., for acquisition and tracking antenna systems on the *Mistram* project. Subcontract from **General Electric Co.'s Defense Systems Dept.**

$665,600—**North American Aviation, Inc.**, Canoga Park, for installation of facilities for the rocket engine program.

$571,000—**Electronic Specialty Co.**, Los Angeles, for a complete airborne missile tow target for the Century jet fighter series.

$541,498—**The Marquardt Corp.**, Pomona, Calif., for AN/GPS-T4 (v) radar signal simulators.

Martin-Baltimore's Subcontracting

The Martin Co.'s Baltimore divisions spent $23 million in subcontracts during the first half of 1960—more than half of it with small businesses.

Baltimore and Nuclear Divisions let a total of 41,487 subcontracts during this period, to firms in 75% of the States of the Union. Maryland, Martin's home base since 1929, received the most subcontracts—19,757 subcontracts having a value of $6.7 million. New York was second with 5158, totaling $3.1 million. California ranked third with 3913 totaling $2.4 million.

Others: fourth, Pennsylvania, 2813 totaling $2.3 million; fifth, New Jersey, 2606 at $1.7 million; sixth, Ohio, 990 at $1.2 million; seventh, Massachusetts, 1195 at almost $1.

The Baltimore division produces the Air Force *Mace*, the Navy Marlin seaplane and components for *Titan*, *Pershing*, *Lacrosse* and *Bullpup*.

The Nuclear division manufactures atomic powerplants, isotopic power devices and nuclear components. Several types of advanced nuclear reactors and atomic propulsion systems are under development.

The figures do not include Martin's other divisions at Orlando and Cocoa, Fla., and Denver.

reviews

BASICS OF GYROSCOPES (two volumes), Carl Machover, John F. Rider Publisher, Inc. New York. Vol. 1, 112 pp., $3.30; Vol. 2, 120 pp., $3.30.

These books present for the non-specialist a basic explanation of the principles underlying the science of gyroscopics. Mathematics are included only where they are essential to comprehension of gyroscope principles.

The books begin with an explanation of the construction and the physics of gyroscope operative. Then they advance to the Commercial types of gyroscopes and their utility for stabilizing purposes, as used in equipment commonly bound to the earth's surface.

Then the author details the changes in gyroscope construction and design as required for application in space vehicles, missiles, etc. Numerical examples are employed to illustrate the operation of the gyroscope.

VIDEO TAPE RECORDING, Julian L. Bernstein, John F. Rider Publisher, Inc., New York. 272 pp., $8.95.

This book deals predominantly with the recording of television signals and considerable space is devoted to electronic photography.

Techniques and mechanics of recording are reviewed and then the specifics of video recording are explained. The various types of tape transports, video track patterns, and basic block diagrams of a television tape recorder are discussed at length.

From this point, the discussion advances to the latest types of equipment in current usage. The video system is discussed in detail, with explanation of the various recording playback circuits and demodulators given.

FUNDAMENTALS OF TRANSISTOR PHYSICS, Irving Gottlieb, John F. Rider Publisher, Inc., New York. 267 pp., $3.90.

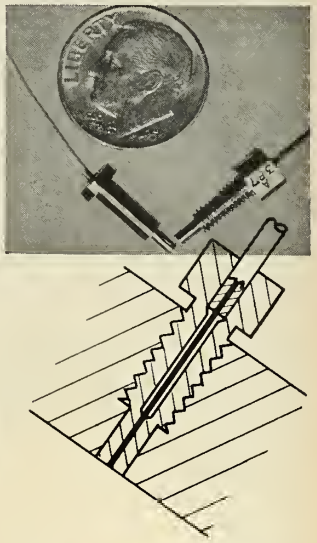
This text provides a thorough analysis of the action of semiconductors from the physics viewpoint. Semiconductor physics is presented in stages, beginning with the theoretical aspects and culminating in the practical transistor and its fundamental circuit. Transistor circuit operations are dealt with only as they amplify the theory.

Of interest to those concerned with recent developments in transistor physics are the four-layer diode, the bilateral transistor, the Zener diode, and the semiconductor variable capacitor. Also covered is the recently developed tunnel diode.

ROCKET SLED DESIGN HANDBOOK, McGraw-Hill Book Company, Inc. New York.

Provided are design philosophy and calculations, pertinent information regarding test tracks and facilities, proven construction practices, a basic glossary of sled terms, abstracts from many pertinent publications (with subject index), and a comprehensive bibliography.

The book represents the latest information and practical experience gained at test tracks throughout the U.S.



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DELTA-COUPLES are precision thermocouples engineered for accurate, pinpoint temperature measurements in steel or aluminum structures. Available in five basic types, DELTA-COUPLES are being successfully applied in the field of missiles and rockets to combustion chambers, blast deflectors, launching structures, injection nozzles, missile skins, and in thermodynamic model studies. Pictured are the S1 and S2 types designed for rapid response measurements at the surface of steel structures.

Write for DELTA-COUPLE Catalog ATL-903

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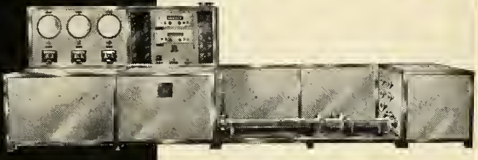

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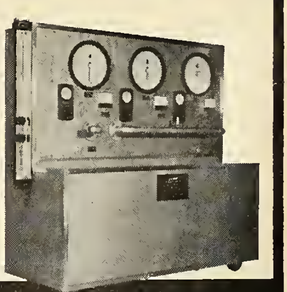

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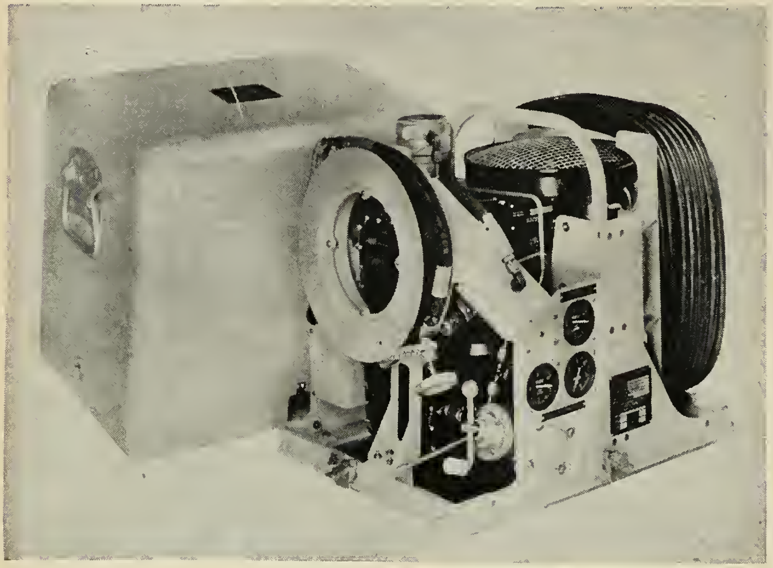

High-Pressure Dry Air Source

A portable air compressor assembly, recommended as a source of high-pressure dry air for missile ground support, test and checkout, is now being manufactured by The Cornelius Company, Aero Division.

The compressor and pneumatic system provides dry, compressed air at a regulated delivery pressure from 0 to 3000 psi.

Capacity of the compressor, Model 130R3500, is two cubic feet per minute of free air at 3000 lbs. psi. Operating speed is 4100 rpm.

The compressor is operated with a 200-volt, 400-cycle, 3-phase power source supplied by an auxiliary power unit. Weight of the unit, with carrying case and skid mount, is 93 lbs. Dimensions of the case are 16 x 18 x 21 in. Delivery pressure gauges are calibrated in 10-lb. increments to 600 psi and in 100-lb. increments to 4000 psi.

Circle No. 225 on Subscriber Service Card.

Liquid H_2 Ball Valves

Liquid hydrogen ball valves with low cool-down weight, for use in rocket engine development, have been delivered by Hydromatics, Inc.

Ranging in size from 3/8 to 8 in. diameters, the valves are encased in welded stainless steel vacuum jackets to insulate the valve body from the surrounding air. This minimizes heat transfer from the surrounding air, eliminating liquid hydrogen boil-off. Top loading permits disassembly for maintenance without removing the valve from the line. Zero leakage and self-lapping seat characteristics are built into the valves.

Circle No. 226 on Subscriber Service Card.

Mobile Welding Gun

A manual Aircomatic (gas-shielded metal-arc) welding MIGet gun and controls have been developed by Air Reduction Sales Co. The gun and controls are designed for use in light-to-heavy fabrication where numerous short welds, off the ground welding, or emergency repairs are necessary.

The gun carries its own compact reel of wire, wire feeding drive rolls, and complete-range wire speed control.

Circle No. 227 on Subscriber Service Card.

Folding Column

A power-operated folding column is available from Wayne Iron Works. It rolls in or out to form a rigid column capable of pushing or pulling heavy loads linearly with a steady force.

The column is formed of hinged links of steel or other channel that are wound helically around a power-operated drum. When equipped with a powering device, the drum feeds out or withdraws the column to transmit large forces. As it unrolls, the column is completely rigid in three directions; however, it must roll out over a flat surface to provide rigidity in the fourth.

Circle No. 228 on Subscriber Service Card.

Frequency Converter

A brushless frequency converter for single-phase drive designed to supply three-phase, 400-cycle power from a 60-cycle source is announced by Georator Corp.

Utilizing a low-slip, single-phase motor built into a cast aluminum shell, integral with a "NoBrush" 400-cycle alternator, the low intrinsic regulation characteristic of this unit eliminates the need for an external regulator. Output of the unit is three-phase, four-wire, 120/208 Volt, 2.5 KVA.

Circle No. 229 on Subscriber Service Card.

Sealless Water Pump

An extremely compact, low-cost, sealless water circulator pump combining motor and pump in a single leakproof unit has been announced by Dynapump Division of Fostoria Corp. The "canned" Dynapump Model 400A is equipped with rubber flanges for extremely quiet operation. It can be installed in any position. Measuring 6 in. x 7 in. and weighing 11 lbs., it handles up to 90,000 BTU an hour in systems with a 20° temperature drop.

It circulates up to 12 gpm and produces a 10-ft. head at shutoff. Designed especially for use on closed water systems free of foreign objects and materials, the Model 400A Dynapump has no stuffing box and requires no seal.

Circle No. 230 on Subscriber Service Card.

Antifouling Hoist

The Garrett Corporation's AiResearch Manufacturing Co. is now in production on its universal hoist, which incorporates a unique and highly de-

Time-Sharing Problem?

IDL MAY HAVE A SOLUTION –

Your data handling system, whether RF carrier or wire transmission line, may require time-sharing to increase its capacity and efficiency.

In the past, the advantages of motor driven switches used for multiplexing were outweighed by their disadvantages. They were smaller, lighter and simpler but, because of high contact resistance, bounce and short life, they contaminated data.

Then IDL introduced multi-fingered brushes traveling on the inner periphery of cylindrical sections to minimize resistance and bounce and extend trouble-free life to hundreds of hours. These concepts have been successfully applied to missiles in sampling 900 data points per second for more than 500 hours without signal contamination even in the milli-volt signal level ranges.

For example, Switch No. 500660 is a complete unit within a compact case, available at reasonable cost and capable of sampling up to 180 transducers. It combines 2 poles of 30 data channels with 2 poles of 60 data channels, each operating at 5 rps.

IDL

For further information, write for Technical Bulletin No. 500660, or let us propose a solution to your Time-Sharing Problem.

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Circle No. 45 on Subscriber Service Card.

sirable positive antifouling mechanism.

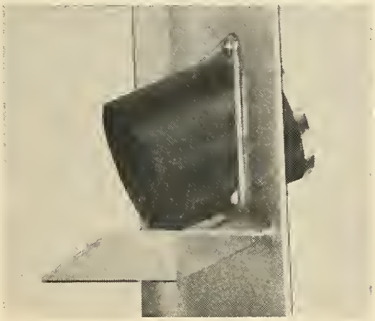
Advantages offered by the AiResearch hoist include advanced antifouling mechanism, compactness, and light weight. The unit incorporates a 115/200-volt, AC, 3-phase, 400-cycle motor. It contains 15 ft. of ¼-in. cable capable of raising and lowering a 1400-lb. load at a minimum speed of 15 ft. per minute.

Circle No. 231 on Subscriber Service Card.

Low-Noise Cooling Blower

The Powair Series of Standard 2-in. blowers by Dean and Benson now guarantees 2000 hour life at 22,000 R.P.M.

The motor is a removable unit and is easily slipped out of the blower. All parts are also interchangeable and available as spares.



The 400 cycle motors of the blowers are constructed of stainless steel and bearings larger in diameter than normally found in motors of this size. New construction versatility also allows endless combinations of flange mountings.

Circle No. 232 on Subscriber Service Card.

Nickel-Plated Couplings

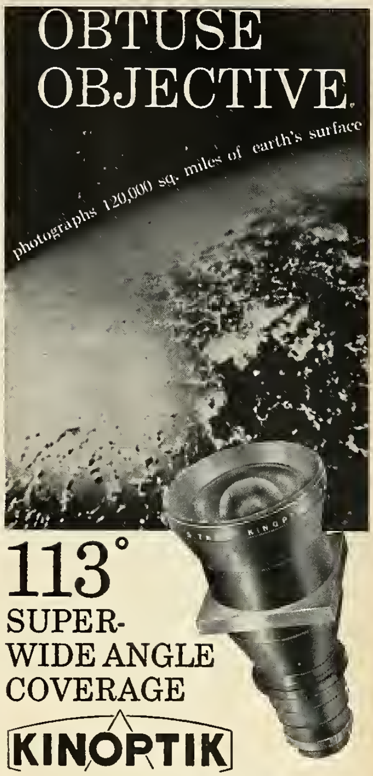
Quick-disconnect couplings, protected by electroless nickel plating are available from Snap-Tite, Inc.

The nickel plating on the coupling is free of voids. The conformity to the surface is so excellent that there is no observable void between the coating and the base material. Under normal conditions, abrasion resistance is very good, and the new plating process produces no effect on the tensile strength or ductility of the steel in the couplings.

Circle No. 233 on Subscriber Service Card.

Ground Radar Motor Pump

Designed and built by Vickers Inc., Division of Sperry Rand Corp., a compact vane motorpump is used to circulate coolant (ethylene glycol and water) through the magnetron tube of a ground radar high-power illuminator antenna. The antennas serve as part of the guidance system for a surface-to-air



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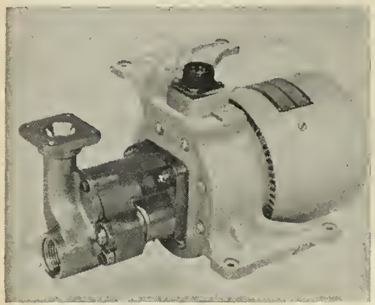


missile.

Designed to operate at temperatures as low as –65°F, the motor-pump provides immediate flow to cool the magnetron tube.

The coolant pump, which weighs approximately 6 lbs., operates at a nominal pressure of 300 psi and has a relief valve setting of 350-400 psi. The three-phase, 400-cps, continuous-duty, explosion-proof electric motor operates on 416-volt, AC current.

Circle No. 234 on Subscriber Service Card.

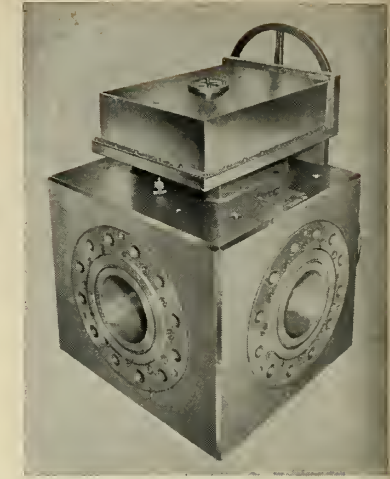
Angular Oscillating Table

An angular oscillating table is available from Micro Gee Products, Inc., for subjecting gyros, accelerometers and guidance systems to extremely smooth sinusoidal motion for precise frequency response tests. A rate pickoff provides instantaneous rate information for presentation on an oscilloscope or recorder. Input to the table may be from any good audio amplifier, dc power amplifier, or shaker amplifier over the range of 0 to 100 cps. Loads in excess of 100 lbs. may be tested. Output torque exceeds 1 in.-lb. per watt input.

Circle No. 235 on Subscriber Service Card.

Three-Way Ball Valves

A new three-way ball valve to handle liquid oxygen (LOX), rocket fuel, and water at pressures from 0 to 1800 psig in missile test stands is available from The Vickery Co. In laboratory tests this new valve recorded zero leakage on liquid nitrogen (LN_z) at –320°F at pressures from 0 to 1000 psig, and on ambient gaseous nitrogen (GN_2) from 0 to 1800 psig.



These three-way valves may be piped for flow thru either of two inlet ports and one outlet port, or thru one inlet port and either of two outlet ports. Opening and closing is controlled by manual rack and quadrant actuator with visual position indicator.

Circle No. 236 on Subscriber Service Card.

Wide Field Radiometer

Barnes Engineering Company's wide-field Radiometer Model R-4K1 is designed for making radiation measurements of small, remote, fast-moving targets against a variety of day and night backgrounds. The instrument is suited for ground-to-air and air-to-air measurements of the radiation from high-speed missiles and aircraft.

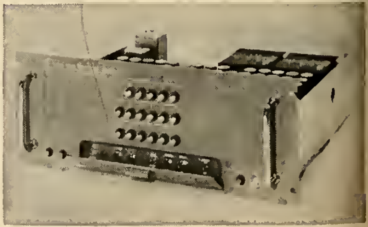
The Radiometer can make either contrast measurements or absolute measurements of target radiation. Selection of the desired mode of measurement is accomplished by installing one of two plug-in chopper packages.

Circle No. 237 on Subscriber Service Card.

Time Code Generator

An all-solid state electronic time code generator is available from the Electronic Engineering Co.

The compact unit supplies either a 17-bit binary coded time signal produced once each second or a slow rate 13-bit binary coded time signal produced each 15 seconds at a 1 pps rate. Both codes indicate hours, minutes and seconds. Seven pulse rates are also available as auxiliary signals. Frequency stability of the ZA-802 is equivalent to one second per month.



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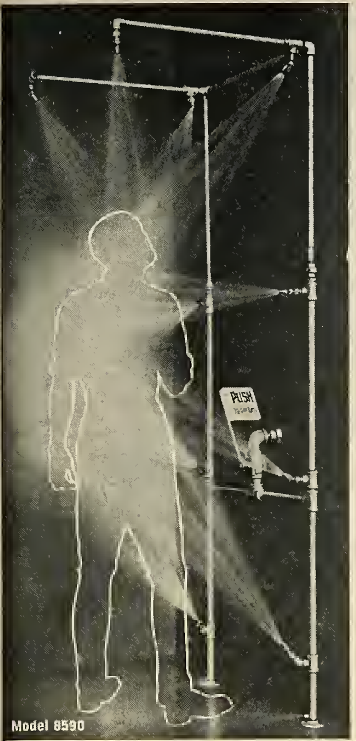

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Circle No. 48 on Subscriber Service Card.

. . . products and processes

Battery Substitutes

Battery replacement units are now available for strip chart recorders, laboratory measuring potentiometers, and other applications which demand a constant dc voltage supply, from Dynage, Inc. The units can be used to replace the 1½ volt dry cell alone, or to replace the dry cell, standard cell and standardizing mechanism in strip chart recorders of all types. Compact packaging allows the unit to be easily installed in existing battery brackets.

Circle No. 239 on Subscriber Service Card.

Universal Power Tester

Transval Electronics Corp. has developed a universal power supply tester that can be used for checkout of airborne or ground support equipment.

The model 9007 Test Console provides AC power for the checkout testing of 60 and 400 cps input power supplies. Its features include controlled high and low line and load transients, controlled rise and fall times, interchangeable loads, pulse generator to simulate sense line transients.

Circle No. 240 on Subscriber Service Card.

Microwave Fault Alarm

The Texas Division of Collins Radio Co. has developed a completely transistorized fault alarm for its microwave systems which is capable of reporting 11 or 17 different fault conditions from each of as many as 30 remote stations.

A transmitter at each remote station continuously scans for faults and simultaneously reports all present to its associated receiver at a supervisory station every four seconds by means of a single AM tone. Because tone spacing is at intervals similar to that in FSK telegraphy, upwards of 30 separate remote stations can report over a single baseband without interfering with other communications.

Circle No. 241 on Subscriber Service Card.

Fast Data Processor

A DP-167 computer of modular construction which adds or subtracts at 167,000 operations per second, multiplies at an average rate of 24,000 operations per second, and divides at an average rate of 16,000 operations per second is being marketed by Westinghouse. It consists of three computer elements—an operand memory, an instruction memory, and an arithmetic and control unit—and a power supply. The operand memory has an access time of 0.8 microsecond and can store 640 words, each consisting of 19 binary

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digits and algebraic sign. The instruction memory's access time is 1.5 microseconds, and its capacity is 2048 instruction words of 20 bits each.

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Parametric Amplifiers

Custom-designed, reactance-diode parametric amplifiers for applications at all microwave frequencies are available from Texas Instruments Inc.

The heart of the parametric amplifier line is the gallium arsenide, variable reactance (varactor) diode which gives greatly enhanced noise performance over a wide range of temperatures down to liquid nitrogen temperature (77°K).

Circle No. 243 on Subscriber Service Card.

Monitors Radar Set Noise

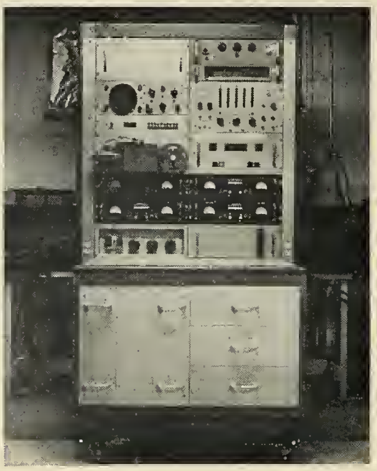
A noise figure meter which directly and continuously monitors the noise figure of operating radar sets is now available from Hewlett-Packard Co.

The noise figure meter, Model 344AR, operates automatically on either a 25 or 30 MC IF Frequency, and is designed for direct application to pulse radars with repetition rates of 90 to 500 pps, or up to 3000 pps with special sampling circuitry. The instrument's fast meter response enables the operator to optimize or adjust the radar system during operation or maintenance. System noise figure is measured on a time-shared basis with the radar scan.

Circle No. 244 on Subscriber Service Card.

System Checkout Tester

ORtronix Inc. has available the ADEPT 400 for automatic dynamic testing of component subassemblies or complete system checkout. Complete flexibility of testing is obtained by control of 295 signal, power and test control lines with punch tape programing. The manufacturer claims greater capability at lower cost than with any automatic Go-No Go checkout system available today.

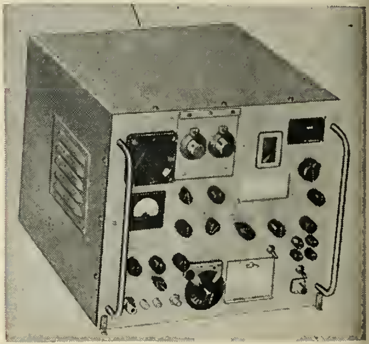


Circle No. 245 on Subscriber Service Card.

Radar Test Sets

Development of two new multipurpose test sets primarily for use with radar systems has been announced by Polarad Electronics Corp.

Operating in a frequency range between 2700 mc and 10,500 mc, each Test Set is a combination of power meter, frequency meter, spectrum analyzer, signal generator and synchroscope. Model CTS-24 covers the range of 2700 to 3550 mc and Model CTS-810 operates in the 8500 to 10,500 mc range.



Circle No. 246 on Subscriber Service Card.

Curved Primary Battery

A curved powerpack—Model P-3000—is a primary (one-shot) unit designed for wide variations in discharge rates (as high as 100 amps continuously) and the most stringent requirements in voltage regulation called for in any battery to date. The unit is made by Yardney Electric Corp.

Circle No. 247 on Subscriber Service Card.

Insulated Thermostat

Chatham Controls Corp. is manufacturing BW-SS insulated thermostat. This ¼-in.-diameter model is available with Chatham's patented wiping action and contacts that open and close with temperature fluctuations. The unit can be factory calibrated or adjusted externally to obtain the desired actuating temperature by means of an easily accessible adjustment screw. The adjustment screw may be hermetically sealed at the factory or by the customer. Temperature setting is not affected by ambient temperatures.

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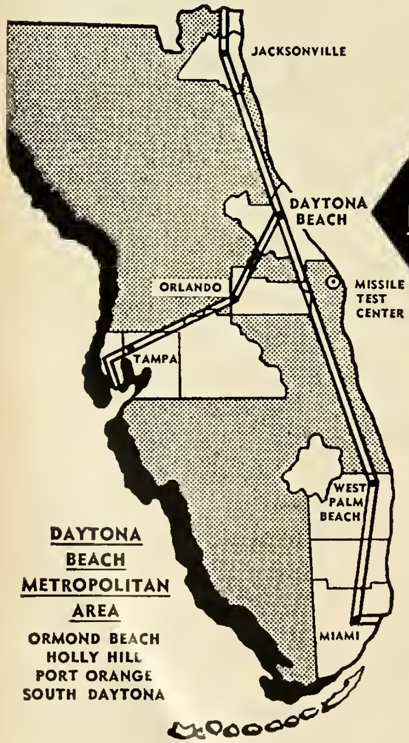

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new literature

IONIZATION GAGE CONTROLS—A series of ionization gage controls for the accurate and uniform measurement of ultra-high vacuum are described in a data sheet, No. 563, just issued by F. J. Stokes Corp. The sheet gives complete specifications for the four models in the series, available either for rack-mounting or in cabinets.

Circle No. 200 on Subscriber Service Card.

ELECTROLYTIC MACHINING—The complete specifications of their line of electrolytic supply units, ranging from the Model 50 (ampere) to the Model 3000 (ampere) size has been published by the Anocut Engineering Co. Bulletin No. 126 also gives the removal rates and illustrates the placement of power components, fuse cutouts, control chassis and blowers for cooling rectifiers.

Circle No. 201 on Subscriber Service Card.

ORIGINAL TANTALUM CAPACITOR—Information on the subject of wet-type tantalum capacitors is provided in a catalog released by Fansteel Metallurgical Corp. The booklet contains specifications, performance characteristics, ratings, curves, and application data. Bulletin 6.100-5 covers Fansteel's "PP" Type Capacitors ranging from 325 to 1.75 mfd, 6 to 125 maximum working voltages for operation at 85°C at full ratings.

Circle No. 202 on Subscriber Service Card.

INFRARED-DETECTORS — Concise descriptions and detailed specifications of Servotherm(R) thermistor heat detector cells are contained in a technical bulletin available from Servo Corporation of America. TB 1300-6 describes Servotherm infrared detectors for detecting temperature variations in a broad range of laboratory, industrial, or military operations that are too fast, inaccessible, hot, or rigid in specifications for direct contect with the target.

Circle No. 203 on Subscriber Service Card.

SPINNINGS—Bulletins covering case istories of a broad variety of metal pinning jobs, complete with technical lata, are available from Spincraft Inc. Jnusual spinning jobs in the military, ndustrial, agricultural, recreational and ther fields are covered.

Circle No. 204 on Subscriber Service Card.

DHESIVES PROPERTIES—Furane lastics Inc. has published an adhesives roperties chart which contains the atest information on epoxy adhesives —their application, cure times and hysical properties. The reverse side of his chart contains such information as est methods, application suggestions and availability. A ready reference for adhesive and paste applications, it should help to remove the guesswork from material selection.

Circle No. 205 on Subscriber Service Card.

TITANIUM METALLURGY—Beta-titanium alloy Ti-13V-11Cr-3A1, providing burst strength to density ratios exceeding one million, is discussed in an Engineering Bulletin published by Titanium Metals Corp. of America. The 32-page manual includes data covering the metallurgy, design, welding and forming characteristics of the alloy—considered the most formable, high-strength titanium grade commercially available.

Circle No. 206 on Subscriber Service Card.

CEMENTED CARBIDES—A booklet on Carmet Cemented Carbides designed for wear resistance is available from the Carmet Division of Allegheny Ludlum Steel Corp. The 12-page booklet gives details on design techniques, various sizes, properties, hardness, abrasion resistance and other information to help designers in selection and application of proper Carmet grade and in design of wear parts and die components that will make the best use of Carmet's unique properties.

Circle No. 207 on Subscriber Service Card.

SOLID LUBRICANTS—The theory and practice of lubrication by solids are the primary subjects in a booklet just published by The Alpha-Molykote Corp. Bulletin 124 discusses boundary friction and the role of solid lubricants in reducing friction and wear under heavy loads and at high temperatures.

Circle No. 208 on Subscriber Service Card.

TUNGSTEN PROPERTIES—A tungsten chemicals specifications catalog has been made available by the Chemical and Metallurgical Division of Sylvania Electric Products Inc. It contains a consolidated listing of the five standard high-purity tungsten chemicals produced by the division. They are: sodium tungstate; phosphotungstate acid; tungstic acid; tungstic oxide; ammonium paratungstate. Specifications in the new brochure include available grades. chemical composition, maximum impurity content, physical characteristics, packaging and applications.

Circle No. 209 on Subscriber Service Card.

PHOSPHOR BRONZE—An 18-page technical handbook on phosphor bronze has been re-issued by Riverside-Alloy Metal Division, H. K. Porter Co., Inc. In addition to a detailed explanation of continuous casting, the handbook includes information on phosphor bronze wire, bars, rods, strip, sheets, circles and special shapes. Flexograin, a special fine-grain phosphor bronze, is also discussed in detail.

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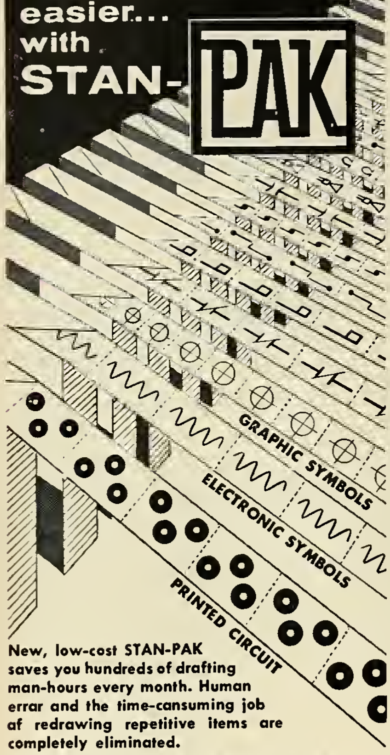

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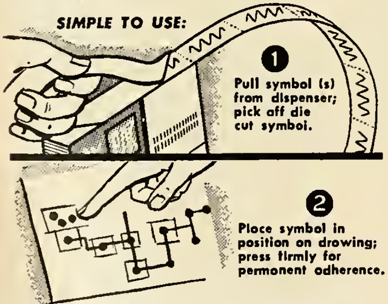

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Engineering Management Conference, sponsored by American Institute of Electrical Engineers and American Society of Mechanical Engineers, Morrison Hotel, Chicago, Sept. 15-16.

Armed Forces Chemical Association, 15th Annual Meeting, Sheraton-Park Hotel, Washington, D.C., Sept. 15-16.

Institute of Radio Engineers, National Symposium on Space Electronics and Telemetry, Shoreham Hotel, Washington, D.C., Sept. 19-22.

Ninth Annual Symposium on Industrial Instrumentation, sponsored by Institute of Electrical Engineers and American Institute of Electrical Engineers, Manger Hotel, Cleveland, Sept. 21-22.

ASME-AIEE Power Conference, Bellevue-Stratford Hotel, Philadelphia, Sept. 21-23.

Air Force Association, National Convention and Aerospace Panorama, San Francisco, Sept. 21-25.

American Ceramic Society, Electronics Division, Hotel Schroeder, Milwaukee, Sept. 22-23.

American Institute of Chemical Engineers, Mayo Hotel, Tulsa, Okla., Sept. 25-28.

American Welding Society Fall Meeting, Penn-Sheraton Hotel, Pittsburgh, Sept. 26-29.

Instrument Society of America, 15th Annual Meeting and Instrumentation-Automation Conference and Exhibit, New York City Coliseum, Sept. 26-30.

American Rocket Society's Space Power System Conference, co-sponsored by NASA, Air Force, AEC, ARPA with cooperation of IRE and AIEE. Miramar Hotel, Santa Monica, Calif., Sept. 27-30.

AFOSR, Conference on Solid State Nuclear Particle Detectors, Asheville, N.C., Sept. 28-30.

OCTOBER

Sixth National Seminar of American Society for Industrial Security, Statler Hilton Hotel, Dallas, Oct. 3-5.

Institute of Radio Engineers, Professional Group on Communications Systems, Sixth National Communications Symposium, Utica, N.Y., Oct 3-5.

IRE Annual Meeting of the Professional Group on Nuclear Science, Solid State Radiation Detectors co-sponsored by PGNS and Oak Ridge National Lab., Gatlinburg, Tenn., Oct. 3-5.

Sixth Conference on Radio Interference Reduction, sponsored by Armour Research Foundation; U.S. Army, U.S. Navy, USAF, IRE Professional Group on Radio Frequency Interference, Chicago, Oct. 4-6.

Briefing Session on Opportunities in Space Age Technology, American Management Assn., Hotel Astor, New York City, Oct. 5-7.

American Ceramic Society, Refractories Division, Bedford Springs Hotel, Bedford, Pa., Oct. 6-8.

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editorial . . .

Where Emphasis on Missiles Belongs

FOR THE PAST several years, the trend in the U.S. military has been toward mobility. Almost every article of armament, from men to missiles, has been equipped with wheels, wings or floating gear.

True, we have the *Thor* and the *Jupiter* in fixed bases abroad, and the *Atlas* and the *Titan* in fixed bases here. The very size of these weapons ruled out the practicality of making them mobile.

But now the Air Force has come up with a challenge to the mobility concept—a plan for hundreds of silo-based *Minutemen*.

The Air Force proposal is based on price—that is, the most bang or the most defense for the least money. AF planners estimate the cost of *Minuteman* in fixed, hardened sites at $2 million each. The cost of *Polaris,* for instance, is about $8 million each. Both figures include the platforms—the hardened silo for the *Minuteman* and the submarine for the *Polaris*. Neither figure includes research and development costs.

In effect, the AF says that if we could have 1000 *Minutemen* in hardened sites it would take the Russians, even with greatly improved accuracy, several thousand missiles of the 10-megaton category to knock out, say, 80% of them.

Even in the event the Soviet forces had this many missiles to expend for this purpose, the argument is made, it would leave them none to deal with our other forces; we would still have 20%, or 200, of our *Minutemen* and enough other forces to conquer Russia.

We find it difficult to regard this proposal with a great deal of enthusiasm. There are several reasons.

What the construction of 1000 hardened missile sites would do to the American landscape is not too pleasant to think about; what several thousand Russian missiles trying to find them would do to that landscape is an even less attractive thought. Plus the fact that it is quite possible that our entire present missile concept might be obsolete by the time we had spent the years and the $2 billion such a project would require.

WITHOUT TRYING to usurp anyone's position as military expert, we would like to suggest that the United States should not spend a pre-emptive amount of money or time on any one weapon system.

If numbers of weapons make us a more difficult foe to disarm, then numbers of weapons in a mixed force make us even more impregnable. We should not spend overwhelmingly on SAC airplanes, on SAC missiles, on Army field forces or on Navy *Polaris* submarine systems.

Forty-five *Polaris* subs (which the Navy wants), each carrying 16 or more missiles, seems to us to be too many. We doubt if they would be effective enough to warrant the cost—at the expense of something else. We also doubt the prudence of buying a thousand *Minutemen,* because the cost would inevitably mean less armament in another area. We would be equally opposed to a thousand missile-carrying B-70's, if they were proposed.

Somewhere there is a balance which will give us the greatest deterrent strength and the greatest ability to absorb the first blow and still go on to win.

This balance should in time become apparent—both to us and to our enemies. It will come through measured judgment and honest decision. But it will not be achieved by putting all, or too many, of our defense eggs in the basket of any one project or any one service.

Clarke Newlon

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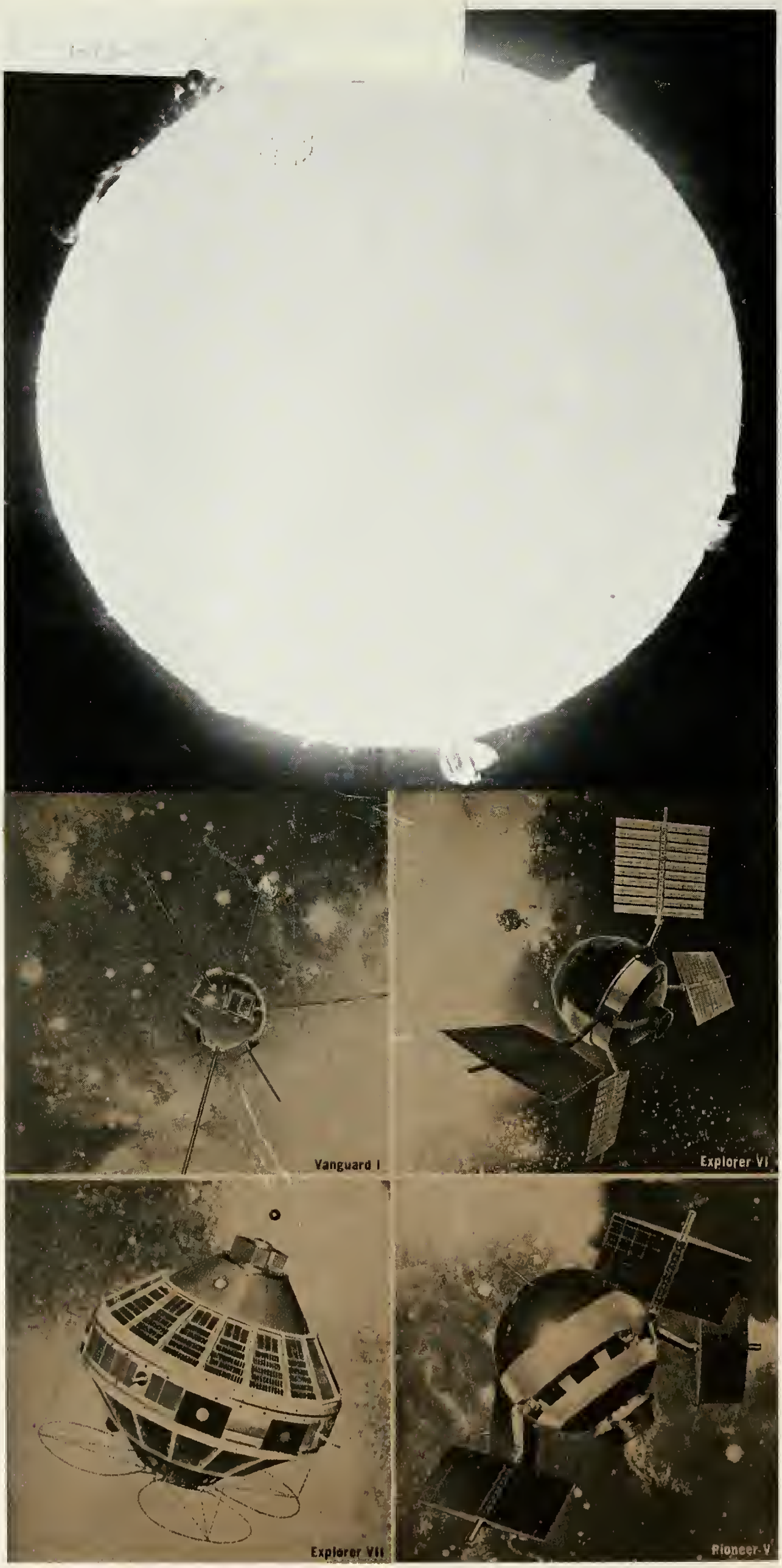

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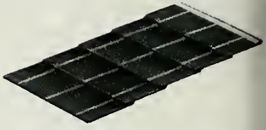

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SEPTEMBER 26, 1960

missiles and rockets

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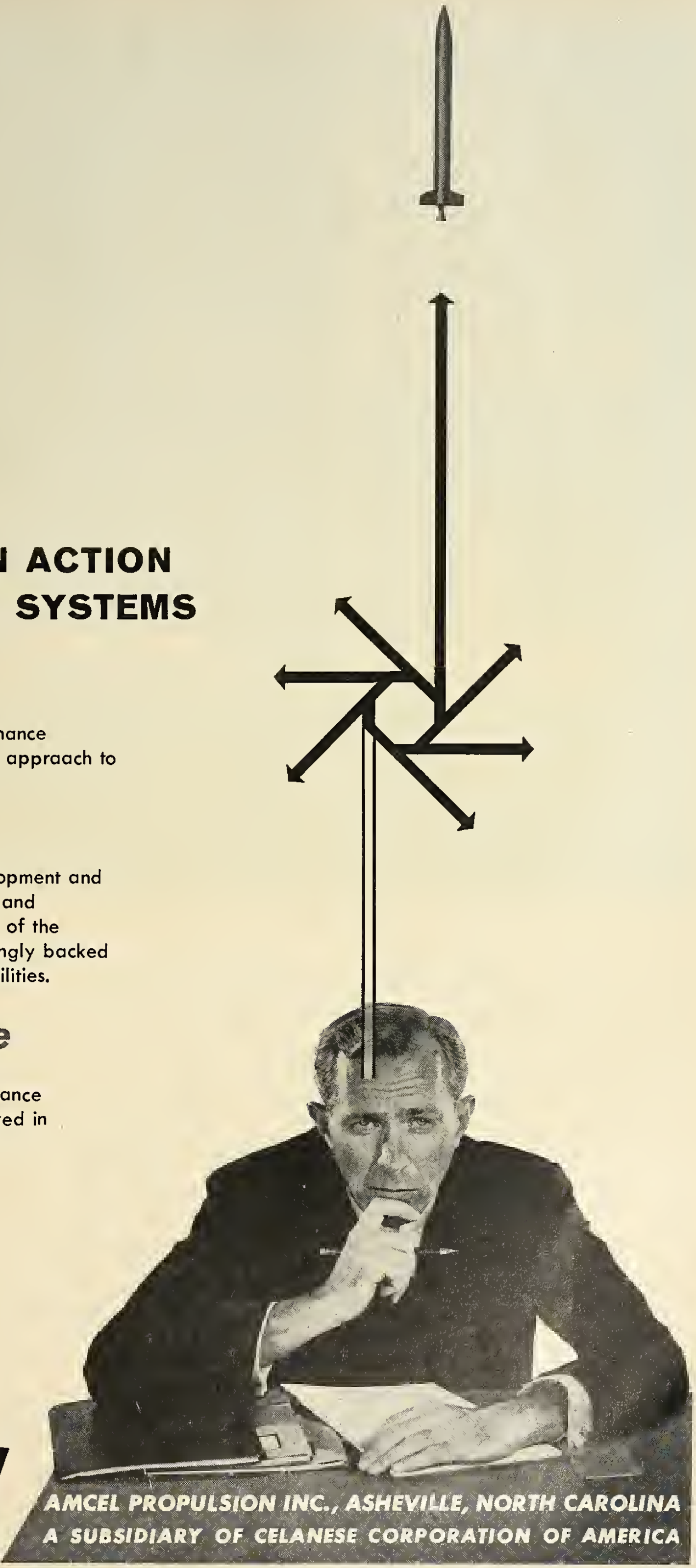

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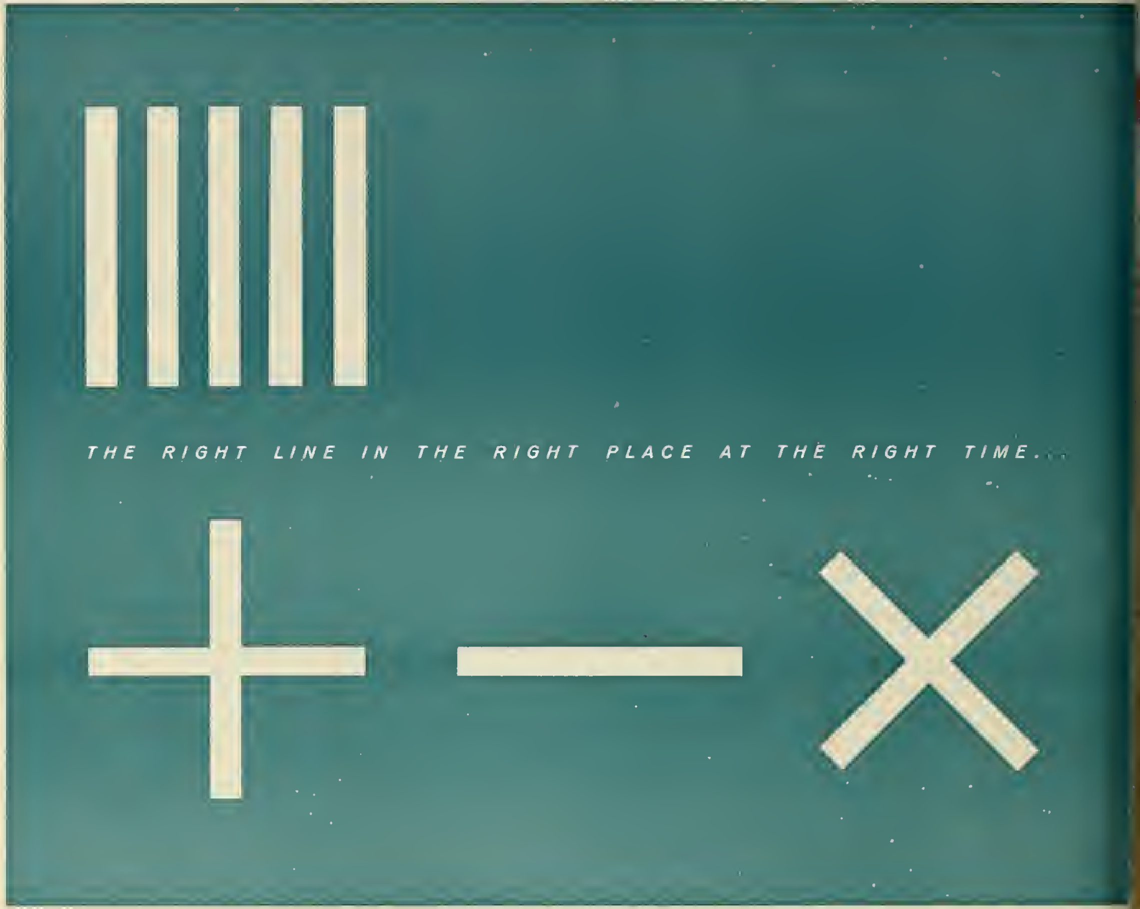
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missiles and rockets

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THE COVER

Worker at Dumont Manufacturing Corp. heat-tacks a layer of glass cloth forming part of the inner shell of the nose fairing for Polaris. See story on p. 20.

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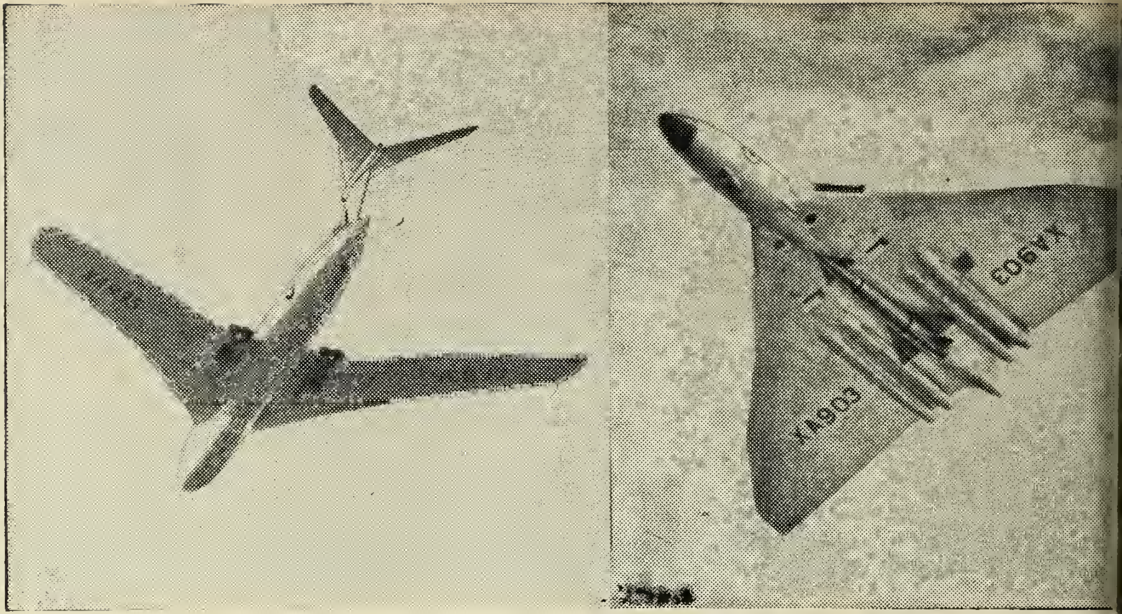

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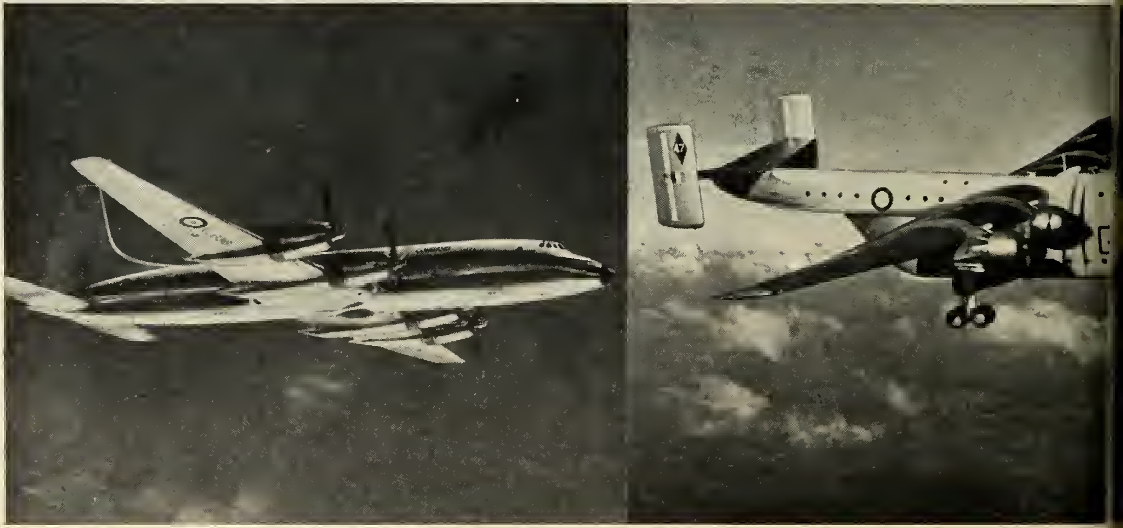

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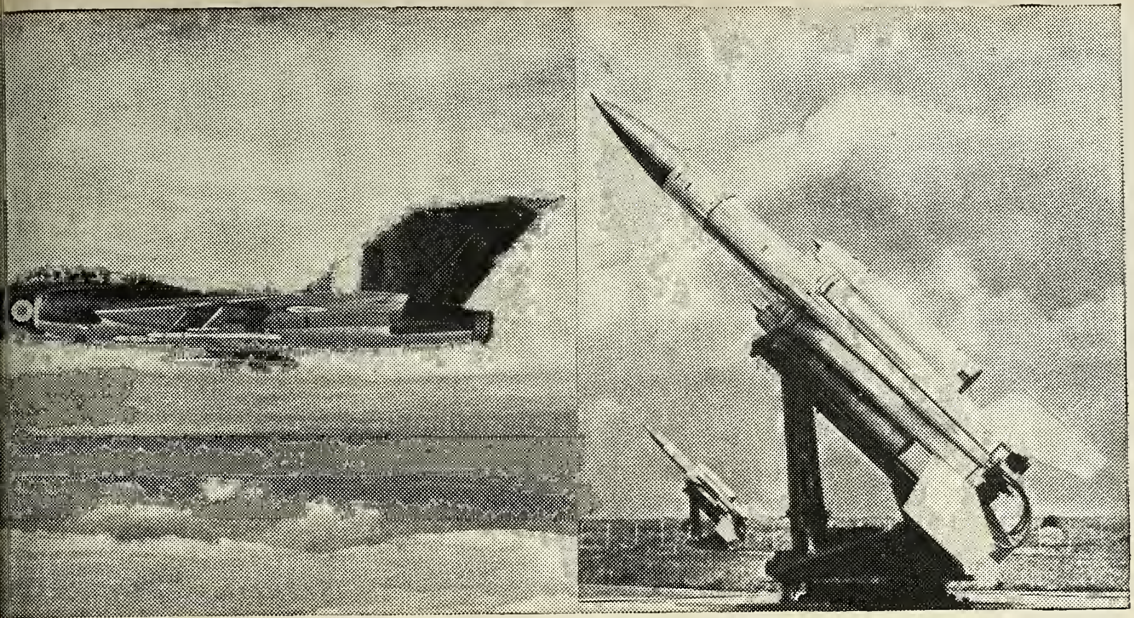
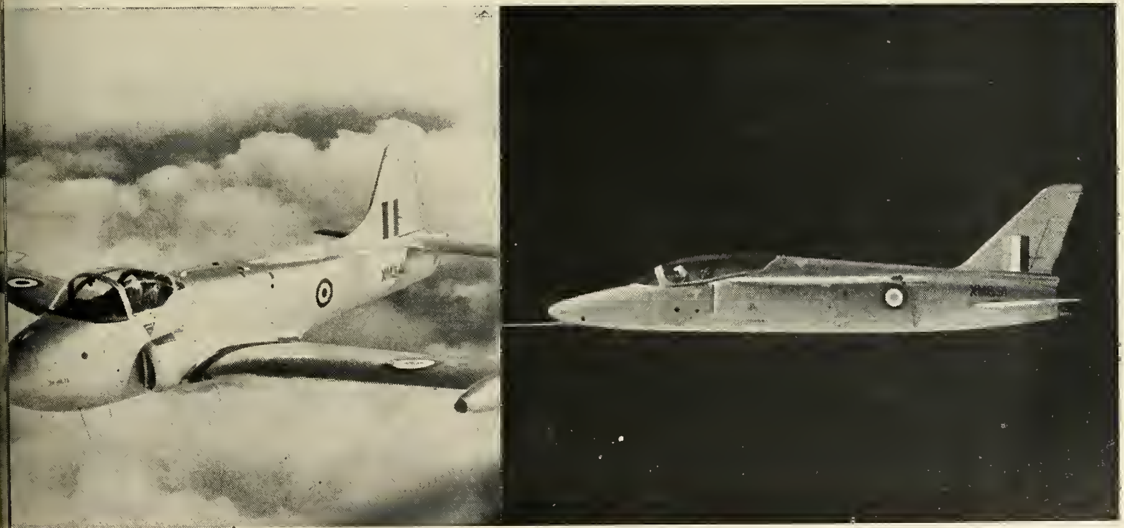


round-the-clock defence intercepts aircraft hundreds of miles out, far up into the stratosphere . . .



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The Countdown

WASHINGTON

Navy Moves on AUTEC

Construction of an ASW missile test range is moving into the study stage. The Navy is holding a bidders conference Oct. 4 for contracts on overall system analysis. No specs are available. The proposal for the range—called AUTEC (Atlantic Underwater Test and Evaluation Center)—was revealed by M/R (Aug. 1 p. 8). It may be located in the Bahama Islands and is expected to cost about $70 million.

Vriting to the Dead

Budget cogitations in the Pentagon these days have a futile air—much like writing letters to the dead. A great deal of the paperwork going on is expected to be meaningless after the November presidential elections, no matter who wins.

1 Billion Watermark

NASA budgeters are working in a cheerier climate. They apparently feel that the FY '62 spending program can go over the $1 billion mark—an increase of 10% over the current fiscal year. NASA Administrator T. Keith Glennan is predicting that the agency's annual appropriations will pass the $1.5 billion milestone in the mid-'60's and level off near $2 billion.

evival?

Word is being spread that the Tactical Air Command's proposal for a tactical ballistic missile, the *TBM*, isn't dead yet. Budgetary plans are being pushed to start development of such a 1200-1500-mile missile in FY '62 —although, significantly, DOD approval is still lacking. COUNTDOWN was told (M/R, Sept. 5) that an identical proposal had been turned down by the Air Force top command. Even if brought back into budget consideration at this stage, the *TBM* is given small chance to survive another shakeout.

eus Tests in '62

Complete system tests of the *Nike-Zeus* against *Atlases* fired into the Pacific are now scheduled for 1962. Identical tests had been planned for next year, using *Jupiters* as targets. But this program was scratched because of the budget squeeze.

Vild Blue Wonder

In a move that yields little to clarity, the Air Force is rechristening its *609A*—the modified NASA *Scout*—*Blue Scout*. The Air Force will call all four-stage model *Scouts Scout*. It will call a three-stage version *Blue Scout I*; a *Scout* with fourth-stage guidance, *Blue Scout II*; still another version, sometimes called the *2356*, *Blue Scout Jr*. Next year it plans to fly 15 *Blue Scout Jr.'s* and 15 *Blue Scout II's*.

INDUSTRY

Sounding Rocket Splurge

The Weather Bureau's '62 budget is expected to show major emphasis on satellites and sounding rockets. The bureau will try again for $5 million to fund communications systems and R&D for weather satellites. It is also looking for money to set up a network of sounding rockets. They would be spotted at 500-to-1000-mile intervals across the U.S.; there would be firings at least once a day in winter and twice a week in summer.

Navy Astronautics Increase

A sizeable increase in its astronautics program is contemplated in the Navy's '62 budget request. One major item is expected to be for a seagoing satellite launcher—a converted seaplane tender.

Execs Wanted

At least one personnel consultant is finding the demand for electronics executives, managers and senior scientists running at an all-time high. For those in the $15,000-and-up bracket there are reportedly more openings than at any time in the past decade.

Sparrow 6-B Competition Gets Hotter

Latest report is that the battle for the propulsion contract on the Navy's new longer-range *Sparrow 6-B* will be narrowed to three competitors next month. Three one-year contracts will be awarded about Oct. 1, and a sole source will be chosen late in 1961. Aerojet is expected to get two of the contracts (solid and prepackaged liquid) and Rocketdyne the third—for a competitive solid motor.

INTERNATIONAL

French Seek Polaris

The French Government under the whip of President de Gaulle appears to be pushing hard for construction of its own nuclear-powered *Polaris* submarines. France wants to buy *Polaris* missiles from the U.S. and equip them with its own nuclear warheads. So far, no agreement has been reached with the U.S. Meantime, de Gaulle's government is seeking Parliament's approval of four ballistic missile subs. At a recent launching, de Gaulle promised they would be forthcoming, adding: "It is I who tell you this."

Overseas Pipeline

Anxiety over Communist Chinese border violations is expected to make India put more money into defense and rocket research . . . France's missile test ship "Ile d'Oleron" will be completely refurbished next year with telemetry equipment suitable for checking advanced missiles . . . Dai Nihon Celluloid Co. is building Japan's version of the *SS-10* antitank missile. Buttons replace the joystick control in the Nord system.

The Polaris will locate and destroy its target some 1200 miles away with the help of Raytheon Weld-Pak circuit modules. These Weld-Pak units, based on an M.I.T. Instrumentation Laboratory packaging concept, are vital elements of the Polaris guidance system. Polaris is one of 22 U.S. Missiles that rely on Raytheon components and equipment.

RAYTHEON COMPANY

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RAYTHEON

Thiokol's 'Man-rated' Engine

Due for first test on X-15 this week, the XLR99 may be the first powerplant enabling man to maneuver in space

by John F. Judge

A ROCKET ENGINE that might ell open a shortcut to maneuverable anned space flight is about to be own for the first time.

It is Thiokol's XLR99-RM-1—the ocket engine designed to hurl the *X-15* rough the upper limits of the atmoshere at 4000 miles an hour.

This engine has been installed in *-15* No. 2 plane and the first powred flight is expected this week. The ight will consist of a series of stopart operations. The engine will not each its minimum continuous thrust vel—a thrust sufficient to break all xisting aircraft speed records.

The designers of the '99 regard its ace applications as a logical extenon of the *X-15* program.

The thrust category of the XLR99 is ch that:

–With a B-70-boosted launch, LR99's could orbit *Dyna-Soar* and rovide maneuverability in space.

–With a Saturn-boosted launch, LR99's could accomplish the same ing or orbit a maneuverable seconderation *Dyna Soar* type vehicle.

–With the *Nova* booster concept, LR99's could soft-land men on the oon and bring them back.

According to its builder, Reaction otors Division of Thiokol Chemical orp., the '99 is the only man-rated gine of its kind in existence.

By "man-rated", Reaction means at the powerplant has been designed om the beginning for pilot control. ith 1200 operations totaling 11 hours nning time in ground firings, the '99 almost foolproof.

The engine has performed in temratures ranging from –65° to 165°F., d also at 300°F. Capability of funcning under all acceleration vector nditions, including negative, has been monstrated.

For the *X-15*, the LOX/NH_3 powed engine is throttleable from 25,000 50,000 lbs. thrust (sea level). But rottling could start at 11,700 lbs. rust, say Reaction's engineers.

With currently available high-energy propellants the engine could develop almost 100,000 lbs. thrust without any major design changes. This would not involve a reduction in its man-rated characteristics.

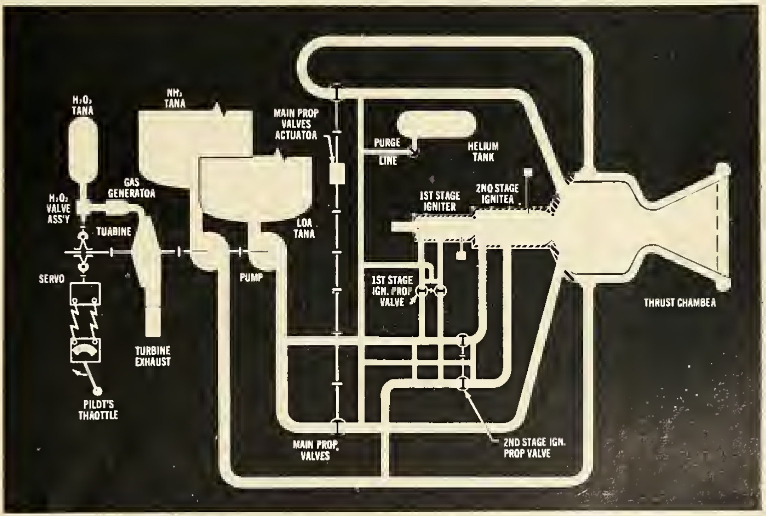
XLR99-RM-1 DATA

Dry Weight	900 lbs.
Wet Weight	1000 lbs.
Envelope	41 in. x 72 in.
Overhaul	1 hour
Turbine Speed	12,700 rpm
Nozzle Expansion Ratio	9.8
Flow Rate (O_2/NH_3)	197.9 lb./sec.
Overall Thrust (Vacuum)	58,500 lbs.
Specific Impulse (Vacuum)	284 sec.
Throttling (Current)	25,000 to 50,000 lbs.
Throttling (Possible)	11,700 to 50,000 lbs.

One of the main advantages of the '99 in manned space applications is that 85% of its operational functions are accomplished before the vehicle is committed.

Engineer Robert Cramer of Reaction outlined the possible uses of the XLR99 in manned space programs. In each case, Cramer is referring to the currently available engine.

• **B-70-boosted**—A 200,000-lb. package consisting of the *Dyna-Soar* glider, propellant and a cluster of three XLR99 engines could be air-launched by the B-70. Using a LOX-NH_3 combination, this package would have the

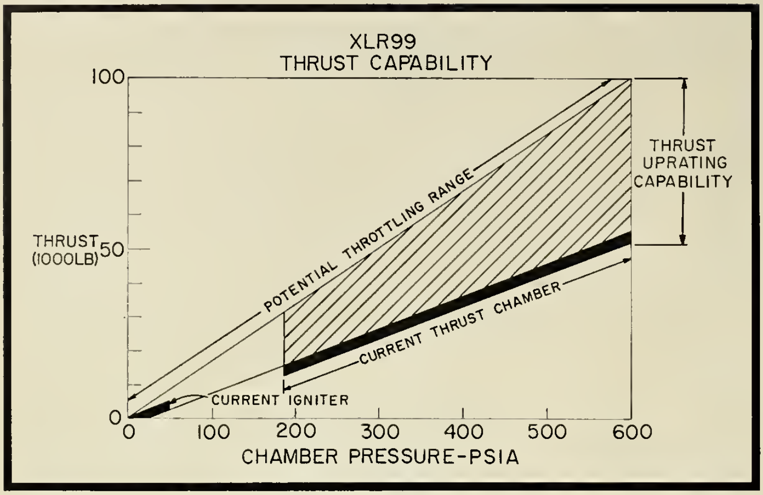


The mere moving of a throttle starts the cycle by actuating a governor controlled metering valve, permitting a controlled amount of H_2O_2 to flow into the gas generator. The peroxide is decomposed into steam and free oxygen which in turn drive the turbo pump. Liquid ammonia and oxygen are delivered to their respective main propellant valves by the turbopump. The ammonia is circulated through the engine chamber walls for cooling during operation.

The propellant combination enters the first-stage ignition chambers and is ignited by an electric spark. Combustion in this chamber signals the opening of the second igniter chamber valves. Operation of the second-stage igniter opens the main propellant valves. The '99 is now in full operation and can be throttled by the pilot from 25,000 lbs. to over 50,000 lbs. thrust.

With a flick of his wrist, the pilot can close the main propellant valves, automatically purging the injector and combustion elements with helium to remove residual propellants.

The combustion of the igniters continues, burning off the remaining propellants. Then these are helium-purged. The engine is completely shut down and can be restarted at will.



thrust capability to orbit the glider with dry fuel tanks.

If the fuel combination was upgraded (higher density propellants) using currently available liquids, the 200,000-lb. package could orbit the glider with propulsive capacity to spare. The XLR99's restart ability could be utilized in space.

In addition, with stepped-up fuels, the cluster might be reduced to just two engines.

The B-70 concept could be broadened to include a lighter package, involving high-energy fuels and two engines to attain orbit.

• **Ground launch**—A 70,000-lb. package consisting of an XLR99 interim booster and the *Dyna-Soar* glider could be easily lifted by the *Saturn.* In this case, the XLR99 would kick the glider into orbital conditions and fall back to earth.

An even more ambitious project would follow the same general lines but add an XLR99 to the glider itself for orbital maneuvering. This would involve a second-generation *Dyna-Soar,* capable of carrying more than one man.

The XLR99 of 1960 is capable of landing a man on the moon and bringing him back. Such a project is undoubtedly in the *Nova* class as far a booster stages are concerned, th XLR99 being the final propulsio means.

• **How safe is safe?**—It goes without saying that the presence of a man in a space vehicle demands a "safe" propulsion system. This powerplant mus also be reliable. The two concepts ar not complementary.

In order to gain maximum safety a series of elements must be incorporated into the engine design. These elements complicate the reliabilit simply because of their existence. Ther is a shift away from simplicity.

According to Reaction Motors, th XLR99 is safe and of proven reliability

On the safety side, for instance there was the problem of a critica accumulated amount of propellant i the firing chamber. This amount is defined as the minimum quantity neede to rupture the chamber under deflagration conditions.

In operation, the '99 can reach thi amount in 1/200 second or about pint out of a flow of 28 gallons pe second. At the time two systems wer available—a race between start an shutdown of the engine or to detect th occurrence of the condition and correct. Neither seemed to be applicabl

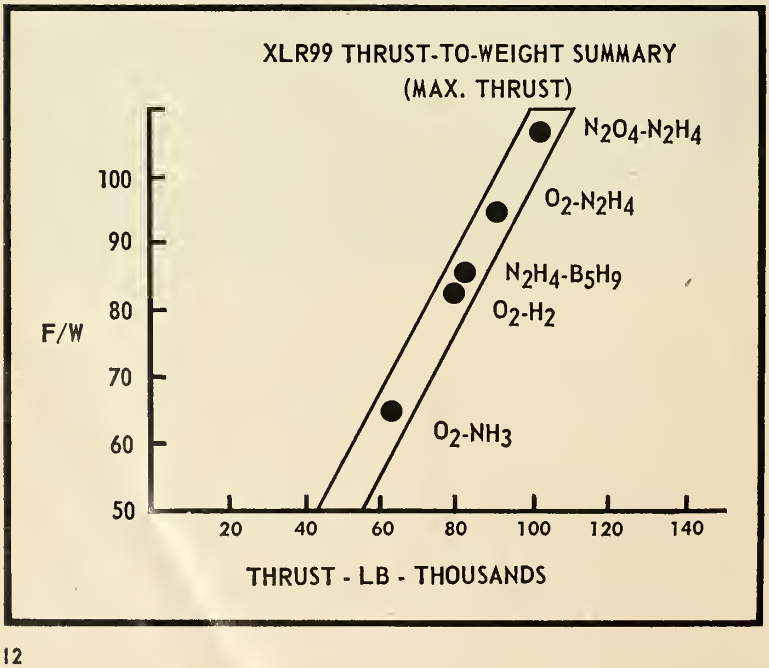
Instead, Reaction Motors enginee designed the problem out of the '99 b staging the igniter subsystem in tw sections. This method allowed an increase in the critical amount by usin a smaller chamber and a changed stat of the propellant (gaseous oxygen).

Thus enough energy is provided t assure combustion of the propella mixture or, if the mix is outside th flammable range, to evaporate it.

Reliability of the '99 is high—better than 98% in the test program. Th re-use feature of the engine allows th designers to shake out the bugs th caused the early failures. Another factor enhacing reliability is that the majority of malfunctions are not continuing affairs. Shutting down the engi may cure the disorder.

An example of this is that only o malfunction occurred in a stretch 68 engine operations. This was temporary in that shutting down and restarting the engine solved the probler

Reaction Motors has a long histo in the use of rocket propulsion f manned flight. From 1943 to the present a conservative total of 798 rocke powered flights have been made in variety of vehicles. Reaction's enginee point out that the fuel substitution characteristics of the '99 make available wide range of performance capabiliti from one basic, fully developed engin



Astronauts, Mercury Bosses Hit Back

STG program directors argue that delays must be expected; astronauts criticize general public's impatience

by Jay Holmes

HAMPTON, VA.—Astronauts and the anagers of Project *Mercury* are talk- g back to critics of the delays in get- ng an American into space.

Everyone at Space Task Group, the ational Aeronautics and Space Ad- inistration agency responsible, insists at *Mercury* is moving at the top eed possible. Delays are natural in a search and development program, ey maintain.

No one from Director Robert R. ilruth to the seven astronauts has any rious doubt that the Russians will put man or two in orbit ahead of Amer- a and possibly very soon.

And no one at Langley Research enter is denying that *Mercury* has llen behind schedule as charged by itics in Congress and elsewhere. ASA and STG officials decline to ve details on the original schedule, wever, on the ground that it was an formal, internal matter—not a prom- made to anyone.

For the record, Gilruth will say ly that it is still expected that a anned capsule will be launched on a llistic trajectory aboard a *Redstone* metime around the end of 1960, and at man in orbit will be accomplished me time in the latter part of 1961.

• **Must set dates**—Navy Lt. Cmdr. alcolm S. Carpenter puts it this way: "You never really know how long will take when you try something w. When starting a new kind of pair on my car, I may tell my wife be done in an hour. When she mes back two hours later—"

"He tells her to shut up," said other astronaut, Navy Lt. Cmdr. alter M. Schirra Jr.

Referring to planning dates, Car- nter declared, "It's unrealistic for yone to expect us to meet such a edule."

Maxime A. Faget, chief of the STG ght Systems Division, commented, 'e've got to have dates for plan- g, to set delivery deadlines for sub- ntractors. Not only do we pick the rliest date possible, but often one a month or two in advance, which may be impossible."

The plan to fire a manned McDonnell capsule atop a *Redstone* booster by the end of 1960 was an example of this type of scheduling, Gilruth said. (The manned shot will probably be the third in the *Mercury Redstone* series, due to begin in a few weeks.)

"If there are no unforeseen problems, the first three *Mercury Redstone* shots can still come before the end of the year," he added. "But we don't like to give glib dates. Too many things depend on what goes before."

• **Unfair comparisons**—Gilruth said the only promise on timing that he ever made was in the summer of 1958 before the old House Select Committee on Astronautics and Space Exploration, in which he said manned flights were "a couple of years off at least."

A Question of Control

Should the military or a civilian agency be in control of space exploration? Mercury astronauts aren't eager to take sides on this issue.

Their own self-control was evident when they were reminded that Lt. Gen. Bernard A. Schriever, ARDC commander, had said that military men in American history have played the major role in exploring unknown regions.

"That's an unfair question to ask us," said Air Force Capt. Leroy G. Cooper Jr. "He's a general and we are in the military. How can you expect us to comment on what he says?"

"We couldn't possibly have a purely civilian effort," interposed another astronaut, Navy Lt. Cmdr. Walter M. Schirra Jr. "Let's call it a U.S. effort."

"I don't see the necessity to draw a distinction, the capsule just has the words 'United States' on its side," said Navy Lt. Cmdr. Malcolm S. Carpenter.

Added Air Force Maj. Donald K. Slayton: "In another 50 years, the effort won't be just national, but international."

The *Mercury* boss said it is unfair to compare rate of progress with an estimate by Wernher von Braun that a man could be sent into space in a *Redstone* capsule "a year after the word go."

"*Mercury* is an entirely different program from Von Braun's Project *Adam*," Gilruth declared.

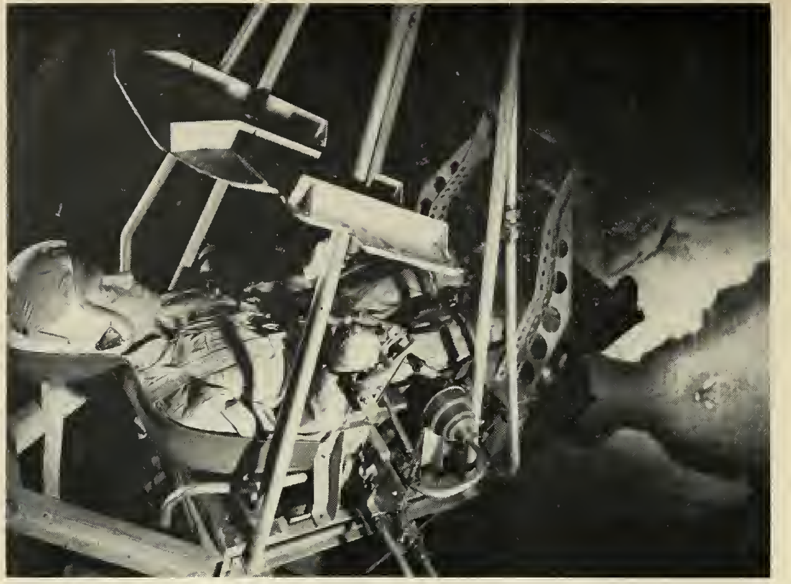
The *Mercury* capsule is much more complex than that for Project *Adam*, he explained, because it is designed for an orbital mission. The environmental control system, for example, is designed to sustain a man up to 18½ hours—2 hours on the launch pad, 4½ hours in flight and 12 hours afterward while waiting for recovery.

"Although we were supposed to use state-of-the-art components throughout the capsule, this wasn't possible," said Richard Johnston, deputy chief of the STG Life Systems Branch. "Of course, we could have done it if we had a Russian rocket available as a booster."

• **Weight handicap**—The sticky point was the orbital capacity of the *Atlas* booster. The whole capsule and the man inside could not weigh a total of more than one ton. Current Russian rockets can orbit 4½ to 5 tons.

Maximum weight of 90 to 100 lbs. was assigned to the environmental control system, Johnston declared. "If we had used existing aircraft equipment, the weight would have been 350 lbs. With their payload capacity, I'm sure the Russians could have used existing equipment."

The *Mercury* environmental control system developed by STG and AiResearch Division of Garrett Corp. weighs 89 lbs. One of its features is a 7500-psi oxygen storage bottle, which was beyond the state of the art two years ago. "The standard oxygen cylinder then weighed 22 lbs. and carried about 2½ lbs. of oxygen. Now we are building bottles that weigh 4 lbs. and carry



MERCURY ASTRONAUT Navy Lt. Cmdr. Walter M. Schirra Jr., shown here on an air-bearing simulator, expressed some skepticism over Soviet man-in-space ability.

SPACE TASK GROUP engineer Charles Olasky at the control panel of a procedures trainer. STG officials say delays are natural in an R&D program like Mercury.

4 lbs. of oxygen," Johnston said.

Under present plans, the complete environmental control system will be flight-tested on MR-2, the second *Mercury Redstone* shot, which is to carry a monkey on a ballistic trajectory, probably late this fall.

Johnston said cabin pressurization was proved out on the first *Mercury Atlas* shot in July, even though the *Atlas* exploded 65 seconds after liftoff.

• **Time factor**—Gilruth and Faget denied also that they had ever sold *Mercury* with the argument that it is a cheaper way to get a man into space.

"We said it would take less time," Faget remarked. "We proposed to take the *Atlas* booster and base design on present state of the art—to keep reliability at a maximum and avoid blind alleys in R&D."

The argument between a *Mercury*-type ballistic shape and an aerodynamic re-entry body like *Dyna-Soar* had to be settled in favor of the *Mercury* shape with emphasis on present state of the art, Faget said. Developing a *Dyna-Soar* would have taken more time.

The STG officials denied that *Dyna-Soar* delays are due to administrativ indecision. "Many technical problem have held up progress," Faget assertec

• **Public's impatience**—Four of th seven astronauts who happened to b present at Langley Research Cente earlier this month denied they ar "blue" about the progress of the prc gram.

"Everyone from Dr. Glennan a the way down would like to see us g tomorrow," said Air Force Maj. Donald K. Slayton. "Who wouldn't?"

"No matter how fast it were to gc we wouldn't be completely satisfied, added Air Force Capt. Leroy G Cooper Jr.

"Impatience is peculiar to the general public," said Carpenter, "not t those associated with Project *Mercury*.

"There's been too damned muc conjecture about the whole thing, Schirra remarked. "Reading history, didn't detect any anxiety on the part o the public about when the Wrigh Brothers would get their plane ai borne."

"The whole thing depends on you idea of what our mission is," inte jected Slayton. "If it's purely a politica maneuver for international prestig then you can't help but be disappointe that we're behind the Russians."

"But there are two philosophies, Carpenter declared. "The people a STG believe this is a research progran to follow without knocking heads tc gether. But the general public alway wants to be first and best."

"It's just like the Olympics," remarked Schirra. "I'm pretty disguste about the hue and cry over Joh Thomas, a great high-jumper, just be ceause he missed one jump in th finals."

• **Waiting for boosters**—The onl doubt heard on this point was e pressed by Schirra, who said, "It woul be very interesting to go back throug the last three years and read all th learned predictions that a Russia would be in space imminently. I'll believe it when I see it."

"Nevertheless, I'd like to borrow on of their boosters," remarked Cooper.

Everyone agreed that boost pow is the key to speeding America's mar in-space efforts. The *Mercury* capsul is tied to the *Atlas* booster. *Dyna-Soa* the Air Force program for a glider-typ space vehicle, depends on *Titan*.

Project *Apollo*, the NASA thre man space ship, must await develop ment of the *Saturn* booster.

"Of course, *Apollo* is nowhere ne maximum effort," Faget remarke NASA will spend $1 milion in the cu rent fiscal year on industry studies c design of the space ship. A prime cor tract is to be let in FY 1962.

How could *Apollo* be speeded "Build *Saturn* faster," Faget replied.

t IRE Telemetry Symposium . . .

Usefulness of Transit Questioned

Speakers hit accuracy of navigational satellite, cite lag in space biomedicine; exhibits feature PCM telemetry and many improvements

by Hal Gettings

THE *TRANSIT* navigational satel-l: may not be as useful as some of its r ponents claim, according to one cerver.

Speaking at last week's IRE Sym-ium on Space Electronics and lemetry, in Washington, D.C., Dr. nrad C. Wan, of Hughes Aircraft, sd that development of a system such a *Transit* for commercial applications ppears needlessly redundant and un-cessary."

He pointed out that commercial s pping does not require now—or for t immediate future—better accuracy tn is provided by present methods. rline requirements are even less singent in this regard.

Dr. Wan did not touch on the ssible use of *Transit* in nuclear sub-rines to periodically check their in-eial guidance systems. The naviga-t nal satellite is most often touted as a global aid for ships and aircraft—sdom mentioned is this more vital vy requirement.

Both technical and non-technical pblems involved in the development c an operational *Transit* system were ctlined by Dr. Wan. He cited the need f greatly increased accuracy, the riability problem, and requirements f new and more accurate maps to eectively use the proposed new t hnique.

On the non-technical side, he took a lim view of prospects for the neces-s y international acceptance by all n rine and air fleets and the crews t mselves. And he said that the cost f tors involved would be of consider-a e interest in a working system, "tech-n al elegance notwithstanding."

• Space biomedical research lacking -Lack of U.S. emphasis on space bio-n dical research was attacked by Brig. n. Donald Flickinger, Air Force sistant for Bioastronautics (ARDC). said that too little is known about t effects of weightlessness and space r liation to allow putting a man into s ce with safety and maximum e ciency.

Gen. Flickinger pointed out that al-t ugh the U.S. was a pioneer in space biology and medicine, since 1952 work in this field has dropped well below what is necessary to allow it to keep up with advances in space flight equipment and techniques.

To bolster our effort, Flickinger advocated two courses of action:

1) A comprehensive integrated program of space biological investigation with broad approach and ground and space facilities to do the job. ("Biomedical investigations on a space-available piggyback basis will not suffice," he said, "and it is time all of us in the space business face up to the realistic and hard facts of the matter.")

2) A plan and mechanism to collect. collate, and disseminate—on a truly international basis—pertinent space biomedical data.

• PCM predominant—In spite of the planned emphasis on space electronics in the Symposium program, most of the 40-odd exhibits were concerned with telemetry and largely ignored guidance and other areas of electronics. PCM (pulse code modulation) telemetering equipment was predominant, emphasizing the growing trend toward digital systems. In addition, some compatible—combination of digital and FM—equipment was in evidence.

Judging by the exhibits, many leading telemetering equipment manufacturers feel that PCM is the coming thing, even though FM-FM will be with us for a long time and will still have many applications with no competition from digital systems.

Epsco and Radiation, Inc.—both old timers in the PCM business—heavily emphasized digital equipment. CEC's Datalab Division showed its version of a "standard" system using circuit-stack construction of primary units which can be put together to fit a wide variety of applications.

Tele-Dynamics introduced a high-speed Dataplexer as the first unit in a proposed complete PCM system. A new analog-digital converter is scheduled to appear in March. Bendix-Pacific announced plans for a complete solid-state system, to be ready by the first of next year.

General Devices, Inc. showed units of its PCM equipment, including high/low-level modular Multicoders which operate with its PDM multiplex systems. United ElectroDynamics exhibited the gold-plated CT-19 system built to operate at temperatures near 800°F.

• FM/FM improved—Several companies are taking the middle road in telemetry development with "compatible" systems that offer some of the advantages of digital techniques but still operate with existing FM/FM ground equipment—a major economic factor in future telemetry development.

Vector Mfg. introduced its version of a completely solid-state modular PCM/FM-FM system with high/low-multiplexer. The Hiloplexer portion of the system can be used by itself to generate a PAM output or, with an analog-digital converter and processor, to produce a digital output to the transmitter.

Hoover Electronics reported considerable success during the past year with its Vernitel equipment. These units quantize voltages into one of 16 discrete levels and a vernier voltage—each controlling a standard FM subcarrier oscillator—to provide FM/FM signals with accuracies reported to be comparable with PCM.

• Other improvements shown—Many companies are showing progress in improving the accuracy and optimum performance of FM/FM systems. Data-Control Systems, among others, is doing much in the miniaturization of both airborne and ground components and in human-engineering operating equipment.

Transmitters, too, showed evidence of improvements in ruggedness, small size, and solid-state construction. Telechrome exhibited an extremely small, well-built 5-watt transmitter. Vector showed what is claimed to be the only solid-state transmitter and power amplifier for telemetering frequencies.

Several firms have gone ahead in developing 2200 mc receivers, although this frequency band is not slated for general use until 1965-70. Both Nems-Clarke and General Electronics Labs had new models on display. ⁂

Defense/Space Issue Hangs Fire in Election Campaign

First test flight last week of *Blue Scout Junior*—Air Force version of the NASA *Scout* Rocket—was marred by a telemetry failure shortly after launch. All four stages performed normally, however, and the Air Force called the 17,000-mile-high shot a success.

This was the first of 15 firings scheduled in the HETS (Hy-per-Environmental Test System) 609A program aimed at experiments in support of military space and weapon systems development. The HETS vehicles use existing solid-propellant engines and can be assembled in a variety of configurations tailored to specific experiments. Building-block technique provides a series of economical, versatile, and reliable vehicles for a wide range of space missions.

Six different solid motors will be used in various 609A configurations:

1) Aerojet Senior (30 KS 120,000)—Conventional motor with steel case and nozzle and polyurethane propellant.

2) Thiokol XM-33—Conventional motor using polybutadiene-acrylic acid fuel.

3) ABL X-254 (Hercules Powder) —Motor case is of filament-wound fiberglass impregnated with epoxy resin and using a cast double-base propellant.

4) ABL X-248—Same construction and fuel as X-254.

5) Aerojet 30 KS 8000—Motor case is steel-tape wound bonded with epoxy resin. Motor has phenolic-fiberglass nozzle exit cone and uses polyurethane propellant.

6) NOTS (Naval Ordnance Test Station) spherical motor—Two stainless steel hemispheres welded together. Has phenolic-lined internal nozzle. Polyurethane propellant used as fuel.

A standard data recovery vehicle has been developed for use with all 609A configurations. The recovery vehicle is a spherically capped cone weighing about 90 pounds. It consists of three basic assemblies: heat shield, structure, and data capsule. No attempt was made to recover this first shot.

All Stages Fire in First Air Force Blue Scout Shot

With the election only six weeks away, a thorough-going debate over the state of the nation's defense and space programs remained largely in the wings of the presidential campaign.

Overshadowed as it was by the U.N. "rump summit," there was a question whether Candidates Kennedy and Nixon ever could get down to specifics on this issue.

Nixon appeared bent last week on remaining aloof—calling for a truce on all talk that would portray the nation as weak. Kennedy continued to hammer away at a theme of strengthening the world position of the United States by promptly building up its defense posture and launching an attack on poverty at home and abroad.

Steering clear of detailed proposals, Kennedy said that if he were elected president he would immediately ask Congress for the "funds and authority necessary to give us a nuclear retaliatory power second to none, making it vulnerable to surprise attack, and a conventional forces so mobile a modern that they can stamp out a brush-fire before it spreads."

Nixon made his "unity" plea saying "we have a responsibility avoiding resort to statements whi tend to divide America" and indic weakness which would encoura Khrushchev.

• **Brush-off**—Earlier, Nixon brush off the space race, contending:

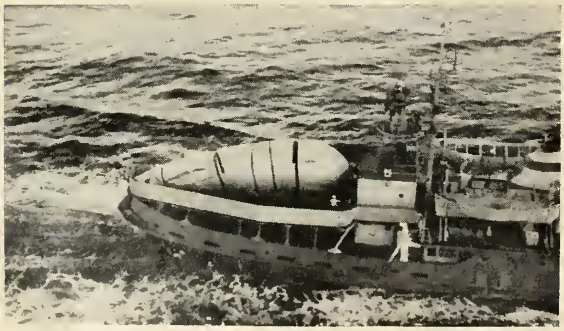
"Our program is coming alo splendidly. If the Russians move ahe of us they won't stay there for long."

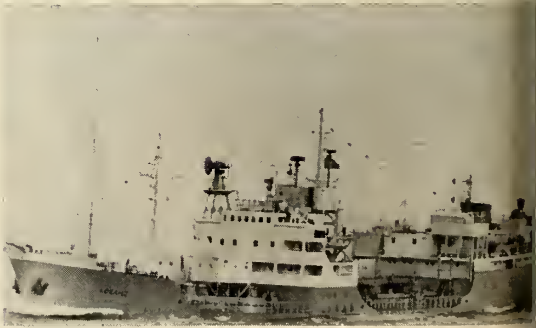
Apparently with this remark mind, and the possibility that a Russi manned space shot or deep space pro was imminent, Kennedy declared th he was unsatisfied to be "second to t moon." He added, "I have heard all the excuses—but I believe, not in America that is first but an Ameri that is first—period." However, offered no approach to achieve this er

Meantime, Khrushchev prepared offer a new disarmament plan strippi the U.N. of all police power, and t U.S. Navy was keeping a watchful e on two antenna-bedecked Soviet shi off the coast of Newfoundland. A though there was conjecture that th could be range ships, informed sourc said the blimp-carrying tug and heavi laden tanker more likely were spy shi (See below.)

The two vessels also were believ to be supplying the Soviet Atlan trawler fleet.

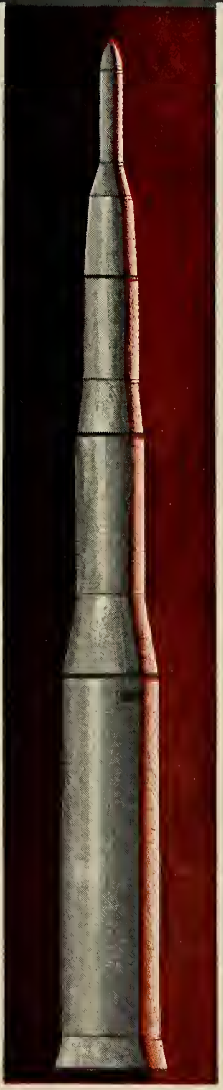
Mission of the trawler fleet was d tailed to the House Committee on U American Activities by Capt. Niko Artamonov, defected Soviet naval o cer, who also said Russian leaders h ordered their military forces in 19 to start preparing for a possible nucl surprise attack on the U.S.





Soviet Ships Operate off Grand Banks

TWO RUSSIAN SHIPS, both heavily instrumented, pursued a mysterious mission 350 miles off the Newfoundland coast last week—ignoring U.S. Navy patrol planes keeping them under surveillance. The tug Fedotov (left) carried a small blimp on its stern and flew it almost daily at varying heights. The heavily loaded tanker Kokand had a small helicopter aft. When a new Soviet space shot failed to materialize on Sept. 19 to coinc with Premier Khrushchev's arrival at the U.N., speculati shifted to the possibility that the ships were on a trawl submarine fueling expedition rather than deployed for ran purposes. It was also possible that their antennas were try to spy on U.S. communications and submarines.



SEALED IN A SECRET SILO

Somewhere in a wasteland, the Air Force Minuteman will keep its lonely vigil all through a thousand nights. Buried and untended, it must be ready to spring to life if the button is ever pushed.

Minuteman poses a real challenge to the New Reliability —reliability which must guarantee successful firing at any moment in the far future. Each of the missile's systems, each of its thousands of electronic components, must function perfectly at that given moment. For once the missile is lowered into its silo, no human hands again need touch it.

The Minuteman's critical guidance and control system has been entrusted to Autonetics. We are proud to be a member of this United States Air Force missile team.

Once again America's defense force reaps the harvest of Autonetics' pioneering. A decade of experience with major projects has given Autonetics a unique capability in systems management—and in meshing its work with that of other companies in building modern weapon systems.

Guidance Systems by Autonetics

DOWNEY, CALIFORNIA

A DIVISION OF NORTH AMERICAN AVIATION, INC. REGIONAL OFFICES: WASHINGTON, D.C. AND DAYTON, OHIO

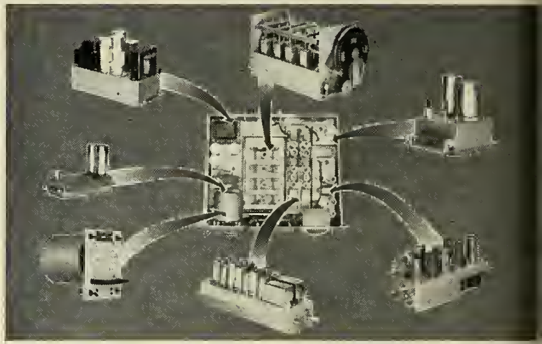
INERTIAL NAVIGATION / ARMAMENT AND FLIGHT CONTROL / COMPUTERS AND DATA SYSTEMS

For more than a quarter century, Hallicrafters has worked in close partnership with our armed forces on fast solutions to critical military electronics problems. Out of this priceless experience are emerging startling new ideas and hard-hitting, fast-moving techniques to keep our country one jump ahead in electronic warfare . . .

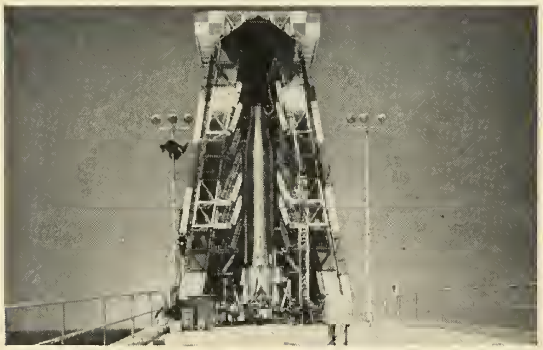
B-52 and other military aircraft will be protected by the most potent Electronic Countermeasures equipments yet devised. These equipments were developed in close teamwork with the Air Force under Hallicrafters' QRC (Quick Reaction Capability) program. Now qualified to meet full environmental specifications, they are in quantity production.

h
hallicrafters
World Wide "Blue Streak" Project

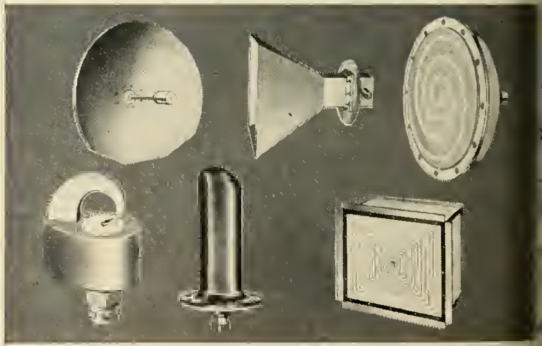
New levels of speed and efficiency are being reached in equipment modernization, retrofit and technical support programs with Hallicrafters' radical new "Blue Streak" project. Specially-trained Maintenance and Technical Support Teams, close-knit and flexible, can be tactically deployed to accomplish maintenance, installation and testing of electronics weapons systems anywhere in the world.



Hallicrafters communications leadership is exemplified by new high frequency Single Sideband receiver, (model no. SX-116). 100% modular design permits simple modification for compatability with existing and future communications systems. Stability, with proper available plug-ins, is better than one part in 10,000,000 per month. Hallicrafters also offers an existing capability in receiving and transmitting techniques up to frequencies of 50,000 megacycles.



Hallicrafters participation in the Atlas missile project helped to develop capability for many areas of the complex missile field, including code translator data systems; ground support equipment; ECM testing and antenna systems. Current explorations involve latest Infra Red techniques.



Airborne antennas and micro-wave components with power capability in excess of 1,000 watts, can be made available to solve tomorrow's very high power handling requirements. Testing of microwave components is possible with special high power generators, designed and built by Hallicrafters.

Looking for a challenging new opportunity? We are interested in qualified engineers at all levels. For full details in confidence, contact William F. Frankart, Director of Engineering.

For further information on Hallicrafters facilities and experience in military electronics research, development and production, please write to:

hallicrafters h company

Military Electronics Division,
Chicago 24, Illinois

Circle No. 6 on Subscriber Service Card.

Technical Countdown

MATERIALS

itanium Cases Likely for Minuteman

Possible replacement of the high-strength steel cases with titanium in the first two stages of *Minuteman* is a likely result of a series of Air Force tests. BMD's Col. J. I. McCoy says that the tests are "showing great promise."

roject Firefly Rolling

ARPA is spending $1 million in learning how known quantities of possible missile trail components interact or react in the upper atmosphere. One goal, of interest to the Air Force, is the elimination of such tattle-tale trails. Above 60 miles these gases may occupy an area 10 miles in diameter and several hundred miles in length. They are detectable by radio energy reflected from free electrons and metal particles.

ockheed Strengthens High-Strength Steels

A cadmium-plating process refinement developed by Lockheed chemists utilizes additives to eliminate the effects of strength-stealing hydrogen gas usually released in plating. The hydrogen is assimilated by a nitrate added to the bath.

ormed Moly, the Easy Way

Based upon the success of using tungsten hexafluoride to form relatively thick and intricate pieces of tungsten through vapor deposition (M/R, Sept. 12, p. 23), an Allied Chemical Corp. chemist foresees molybdenum hexafluoride being used soon in a similar process to form molybdenum pieces.

iberglass-Plastics Boom

Everybody is getting into the fiberglass-plastic case business. Current gossip is that all three stages of *Minuteman*, both stages of *Polaris* and both stages of *Sky Bolt* will go to the lightweight material in advanced versions. (See p. 31.)

lloy Selection Made Easier

A device using a master diagram and any three of the four main design variables (stress, temperature, material, creep time or rupture rate) immediately determines the fourth variable. Studies at Union Carbide Metals Co. on the creep-rupture behavior of alloys near their melting points established the method, among other things.

P rous Metal Process Evolved

Mott Metallurgical Corp. has come up with a new rocess to obtain controlled porosity in stainless steel, ron-nickel alloys and other high-temperature alloys. Typical product—a porous stainless steel wind tunnel nodel permitting flow through the nose at a rate six imes faster than the flow through the base.

PROPULSION

ABM Static Tests OK

Aerojet has had two successful static tests of the rst stage of the *Sky Bolt* ALBM. Douglas makes the teel case of the two-stage missile, which is a little maller than the Army's *Pershing*.

Comanches and Delawares are Coming

Two new high-performance sounding rockets, using the *Cajun-Apache* case, are under development at Thiokol's Elkton, Md., plant: The *Comanche* will employ the polyurethane propellant used in *Subroc;* the *Delaware* will use *Minuteman* PBAA propellant.

ELECTRONICS

Floating Telescopes Next

A recoverable balloon-borne telescope with an appropriate telemetry link to ground comprises a satellite detection system being developed by Electro-Optical Systems for the Air Force. Immune to countermeasures, says EOS, the system will use a 20-in. Bouwers telescope suspended 300 ft. below a 200-ft.-dia. balloon to pick up satellite-reflected light over several hundred miles range. Coverage includes 360° azimuth, 15° to 75° elevation.

And More Telescopes Proposed

A new instrument was proposed for stellar measurement by General Mills' Mechanical Division before the IAF in Stockholm recently. Called a Stellar Aberrascope, it could be used to measure changes in positions of two nearly diametrically opposite stars with vastly improved accuracy. The electro-optical system would use two rotating rigidly mounted telescopes, facing in opposite directions. The company is currently developing a "self-contained guidance" package using such an instrument.

Saturn Checkout Bids Due Soon

NASA's Marshall Space Flight Center, Huntsville, Ala., is asking for bids by October 1 on an automatic checkout system for the *Saturn* booster. The contract will call for study, design, system fabrication, and complete testing—all to be completed within 16 months.

New TV Program Scheduled

Lockheed Electronics' tiny 2-lb. TV camera will permit a revolutionary advance in missile flight performance testing, its developers say. Coupled with its new FM/FM telemetry transmitter, the battery-operated system is designed for use inside or outside a space vehicle. Chief advantage in system is real-time readout at ground stations. (See story on p. 26.)

Device Upgrades Radar Images

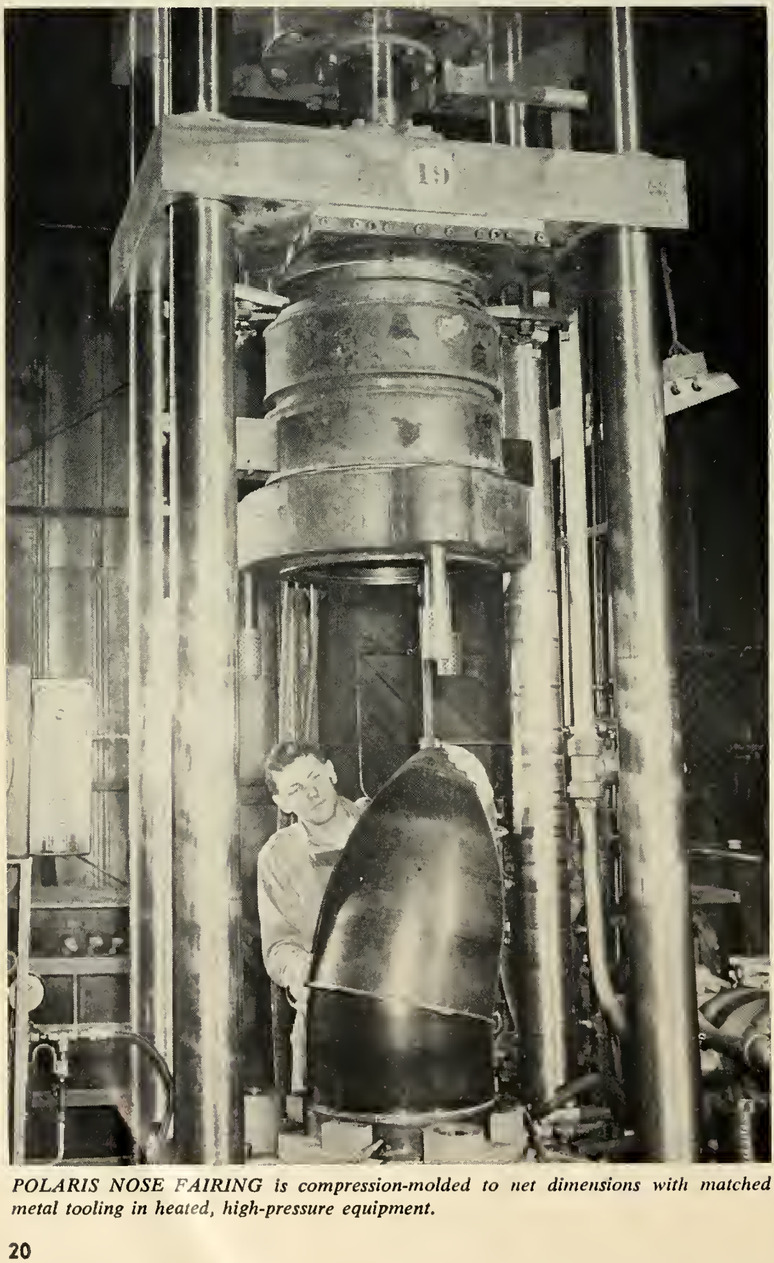
Clear target signals even at maximum operating range of a radar can now be achieved with Chance Vought's new Video Correlator, says the company. A distinct image can be maintained even under conditions which would normally obscure the target. The VC, according to its developers, performs post-detector correlation of the video signal—that is, it sorts out target pulses from degrading noise and interference. It does this by using the uniform spacing or delay between reflected pulses and eliminating all others.

Ryan Forms New Subsidiary

Ryan Communications—a newly formed subsidiary of Ryan Aeronautical—will specialize in solving specialized communications problems. Since H. F. Meyer is Executive VP of the company and co-inventor of the orbitalscatter concept, it is assumed that advanced research at Ryan will include such exotic methods of communications.

Plastic Fairing Guards Polaris Nos

Lockheed and Dumont engineers collaborate on producing reinforced plastic cup; inner shell of glass cloth layers wrapped with glass fabric tape gives lightweight insulation without degradation



POLARIS NOSE FAIRING is compression-molded to net dimensions with matched metal tooling in heated, high-pressure equipment.

THE KEY To both hydrodynam
and aerodynamic drag reduction c
the *Polaris* missile is a cup-shape
nose fairing made of reinforced plasti

The fairing protects the tip of tl
re-entry vehicle through atmospher
exit.

While it will not approach an a
lation stage during operation, the fai
ing's temperature will reach appro
mately 1000°F inside the structure a
possibly as high as 2000°F outside b
fore separation from the missile.

Successful fabrication of the fa
ing and its internal components w
achieved by close collaboration b
tween Lockheed design engineers a
the Dumont Manufacturing Corp.
San Rafael, Calif., a subsidiary of D
tron Corp.

Reinforced plastic construction w
selected for reasons of weight and
provide insulation. Silica tape is us
for the nose piece to satisfy the hi
thermal environment. The stress
quirements are all designed into
inner shell of glass cloth, which is
turn wrapped with a glass fabric ta

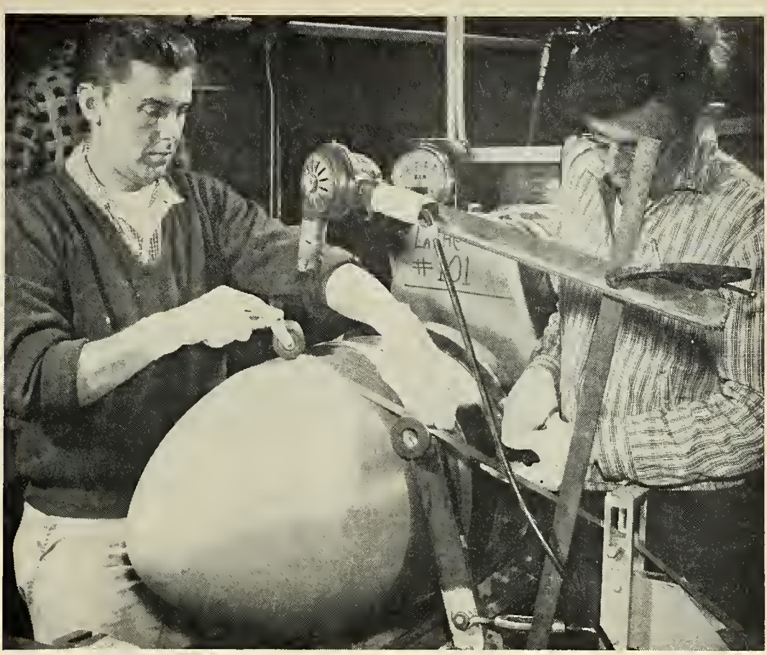
The reinforcing materials are p
impregnated with a heat-resistant p
nolic resin which supplies the high
possible tensile strength in the 500°
1000°F range for approximately
to 125 seconds.

• **Wrapping technique**—Since
aerodynamically smooth surface m
be maintained through exit conditio
the fairing has to perform without
temperature degradation. An erosi
resistant surface is assured by me
of a new technique involving shin
wrapping the outer shell with the ta

The inner shell (see cover) of
fairing is the structural component
the assembly. Seven parallel plies
181 glass cloth are performed o
male mandrel with each layer
tacked in place and trimmed before
next is applied. The mandrel is t
mounted in a lathe for the tape w
ping operation.

Starting approximately 18 in. fr
the nose, a 1-in. strip of glass fa

uring Exit



OUTER SHELL is wound shingle fashion with overlapping layers of tape. The inner shell visible is composed of seven layers of glass cloth.

ape is spirally wound over the glass loth to produce a shingled surface onstruction. Uniformly increasing wall hickness is built up by overlapping to xpose ½ to 1/8 in. of the previous inding.

The tape is applied to within 3 in. f the nose through a cam-controlled etering device.

A nose piece, separately shingle- rapped with silica tape, is fitted to the reform after the glass tape is wound. his extends 5 in. down the fairing.

The preform is placed in matched etal tooling and press-cured for 1 our at 300°F. Final machining is re- uced to a bare minimum because of umont's tooling design. The fairing molded to a tolerance of ±0.005 in.

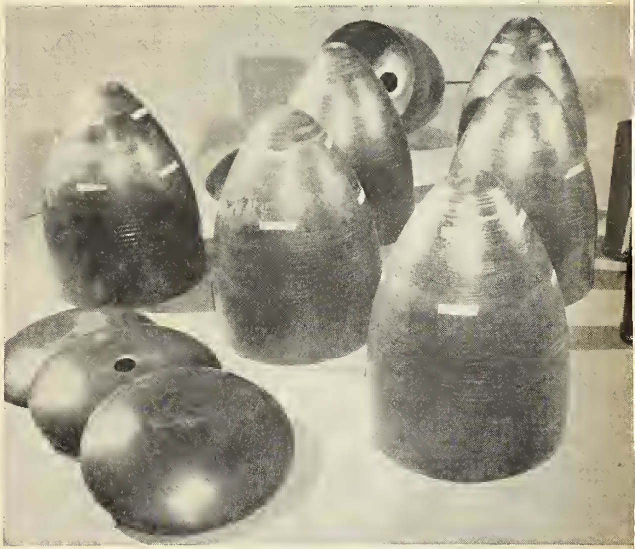
• **Strengthened structure**—Post-cur- g is accomplished in a specially de- gned fixture to minimize distortion d dimensional changes. The fair- g's high-temperature structural re- uirements call for post-curing to a maximum of 500°F.

The inner structure of the fairing is the ejection mechanism. The parts are made of reinforced plastic and add to the structural capabilities of the assembly, while also serving to support it.

A dome-shaped bulkhead is bonded to the skirt of the fairing to stabilize its concentricity and to add strength and stiffness. A tubular piece connects the center of the bulkhead to the nose section.

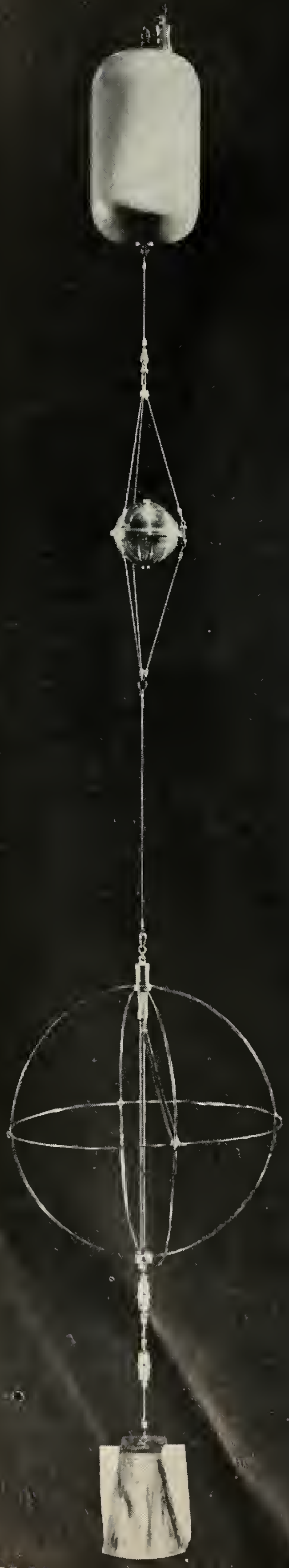
The entire structure inside is bonded to the fairing with a high-temperature epoxy-phenolic adhesive (MIL-A-8431 Type II), which will maintain a required structural load in the 500 to 1000°F range maximum for less than 60 seconds. Since reinforced plastic is used instead of metal, structural adhesives could be employed. The insulation properties of the plastic keep the inner bond line temperature below 1000°F. ⁂

ALITY CONTROL is maintained by Dumont at each step o fairing fabrication.



COMPLETED ASSEMBLIES contain the dome-shaped bulkheads for concentricity stablization and stiffness.

Navy's AIDA Studie



←

MODEL OF AIDA shows its major components strung out as though for a descent to the ocean floor. At the top is a flotation bag, followed by instrument package, electromagnetic antenna and anchor.

USS STALLION crewmen lower gasoline-filled bag for 1½-mile test dive of AIDA.

AFTER INSTRUMENT package passed all of its tests, initial use was off Nassau.

THE NAVY HAS DEVELOPED a standard instrument for exploring the ocean at any depth. It's called AIDA—for Automatic Instrumented Diving Assembly.

It can be made for $10,000—far less than the cost of a bathyscaphe—is reuseable time after time except for replacing an expendable 2½-ton concrete anchor, and is unmanned.

The first successful test of AIDA components was completed off the Bahamas this spring; the first full-scale use of the complete device took place early this summer off Nassau. It will be used off Nassau again next month to make electromagnetic measurements.

Developed by physicists at the Naval Ordnance Laboratory at White Oak, Md., AIDA is now on its way to becoming a program device, a standard research tool for the Navy and its contractors.

The instrument was designed primarily to make magnetic, electromagnetic, radioactive and acoustic measurements at the ocean bottom. It can also be used for underwater photography, bottom sampling, and deep-ocean gravity and current measurements.

Depending on the experiment, AIDA can operate on a sea bottom for a period of many months, perhaps years. Weight is no problem, either: almost any heavy equipment can be lowered and raised by the same technique if an appropriate float is used.

Although the system is usually bottom-seeking, it can be ballasted to lay at any desired intermediate depth. AIDA is designed to resist 20,000 psi., a pressure equivalent to about 8½ miles of ocean depth, more than any sea known.

NOL physicist Abraham Silverstein conceived of AIDA. He points out that the device is free of self-generated sonic and electromagnetic fields. Extremel low-level background detections can be made, since only the measuring instruments themselves have to be quieted.

AIDA's center of activity lies inside a 29-in.-diameter sphere. This holds the sensors, recorders and power supply. Below the sphere are three 10-ft.-diameter antennas, and below these ar anchor-release mechanism and a concrete anchor.

Above the sphere is a rubber gasoline-filled float topped by a small radic transmitter.

When the complete system i dropped over the side of the launchin vessel, the anchor carries AIDA to th bottom. At a pre-set time, a cloc mechanism in the anchor-release circui fires an explosive coupling; the ancho is severed from the rest of the systen and the flotation bag pulls AIDA bacl to the surface. Free of the water, th radio transmitter begins sending out signal to monitoring stations. Recover

cean at Any Depth, at Low Cost

by William Beller

NTENNA FOR detecting electromagne- c fields is lowered for calibration tests.

FIRST OVERBOARD is anchor, cut loose by explosive bolts before AIDA ascends.

ssels home on the signal and retrieve e device.

- **Nerve center**—AIDA's instrument se comprises two 29-inch diameter mispheres of one-inch thick tool eel, which are said to be the largest eces of fabricated tool steel ever ade. They were forged and then ma- ined and finished for NOL by Stand- d Steel of Lewistown, Pa.

The two-part housing hangs sus- nded at the junction of six stainless eel cables, three from above and three m below. They terminate in swivel s to keep the cables from twisting.

Inside the instrument case is a con- ntional tape recorder—not the type ed on satellites—which is multichan- led and used to record phenomena ch as sonic signals, particle impinge- ents and electromagnetic radiations at a bottom.

There is also a pressure gage of ex- eme accuracy, 1 part in 10,000. To t such accuracy, a strain gage and re- rding (multichannel) galvanometer mbination is used. The gage picks up essure-induced strains in the instru- ent case, which are then measured d recorded by the galvanometer. This ethod results in a twofold order-of- agnitude increase in accuracy over at obtained by usual pressure meas- ement methods.

The temperature data are taken by platinum resistance gage whose output is also measured and stored by the recording galvanometer.

Other items housed in the case are standard nickel-cadmium batteries for the power supply, an inverter, and transient devices peculiar to individual experiments.

- **Electromagnetic pickup**—Three 10-ft.-diameter loops comprise the antenna for receiving the electromagnetic signals. These run to a low-noise 3-channel amplifier mounted on top of the antenna. From here, the reinforced signals go to the tape recorder.

This antenna-amplifier system is highly sensitive, being able to detect signals three to four orders of magnitude less than are usually detectable—signals as low as $(5/f)$ x 10^{-9} gauss, where f is frequency in cps.

The loops are set mutually perpendicular in order for the signal vectors to be known. These vectors can be oriented with respect to North.

A suprisingly strong and rigid structure is built out of the loops. They are made of #6 power line cable with 5000-volt insulation, wrapped in glass tape, and then impregnated with epoxy resin.

- **Finding AIDA**—To give the system a voice so that it can be found after it surfaces, a radio transmitter is attached to a platform on top of the float. The transmitter broadcasts a four-megacycle intermittant signal—one second on, two seconds off. It is strong enough to be picked up by communication receivers a hundred miles distant.

The transmitter is for retrieval use only, not for telemetering. Signals are radiated from an eight-ft. antenna whip. Damage to the whip cuts down the power of the radiations but will not extinguish them or change their frequency.

A conductivity switch turns the transmitter off when it is immersed, and on when the radio breaks free of the water's surface. Such a switch draws negligible current when immersed—about five milliwatts—and, of course, no current when above water and not conducting.

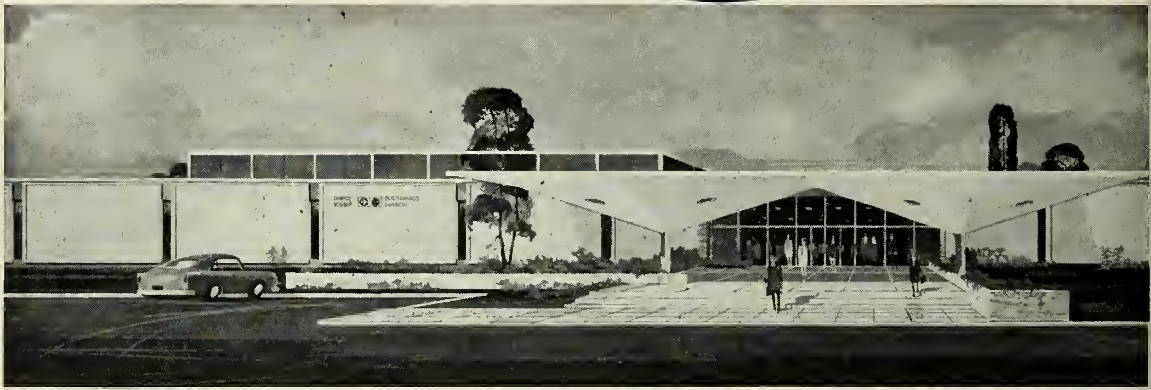
Power comes from Silvercels, 80 watt-hours capacity. During transmissions, the drain is one watt. Therefore, the transmitter is good for about ten days' broadcasting. The system is transistorized for power efficiency and durability.

- **Flotation gear**—A gasoline-filled heavy carcass rubber bag is the last piece of assembly to go over the side prior to a dive. During the operation, the float and its entrail is handled by a crane and winch.

A central steel cable runs through the bag to give it strength in tension. Except for a minor modification, the bag is essentially a standard commercial container made by U.S. Rubber. It measures four feet by seven feet, holds 520 gallons of liquid, and will support 1500 pounds when filled with aviation gasoline.

AIDA is at present set to descend at about six miles an hour, slow enough to get continuous and quite accurate readings of ocean phenomena down to the lowest depths. Thus the device provides a new and inexpensive tool for the study of one of the world's last remaining unknown areas.

The device may even be used for ASW. With a hydrophone replacing the electromagnetic antenna, AIDA would be a passive listener. It would be energized for a long period of waiting by a nuclear battery. When an enemy sub triggered its explosive bolts, AIDA would rush to the surface to broadcast the alarm. ⁂



NEW $3,500,000 FACILITY ANNOUNCED BY VOUGHT ELECTRONICS

On July 21, Vought Electronics broke ground for a new $3.5 million facility in the Great Southwest Industrial District, midway between Dallas and Fort Worth. Completion date for the ultramodern 80,000 square foot building is January 1961, with expansion to 175,000 square feet projected within the next few years.

Complete Electronics Facility The completely self-contained facility will house engineering, assembly and manufacture, quality control, marketing, finance and administrative areas. Also included will be five laboratories — inertial guidance, servomechanism, fluids, microwave and environmental — all with advanced equipment.

Diversified Products Recent major Vought Electronics contracts include: production of actuators for the *Minuteman* ICBM, factory check-out equipment for the inertial guidance system of the *Titan* ICBM, guidance systems and autopilots for the new *Crusader* F8U-2N fighter.

Among other new products are an aircraft navigational system, space vehicle guidance units, ASW devices, advanced antennas, a commercial fingerprint identification system.

FOR COMPLETE INFORMATION ON HOW THE NEW VOUGHT ELECTRONICS FACILITY CAN SERVE YOU, write:

B. H. Ciscel, general manager of Vought Electronics (left) and A. G. Wynne, Jr., president of Great Southwest Corporation, check details of new facility.

CHANCE VOUGHT ELECTRONICS DIVISION DALLAS, TEXAS

ANTENNAS • AUTOMATIC CONTROLS • NAVIGATIONAL ELECTRONICS • GROUND SUPPORT ELECTRONICS

AF Turns to Transistorized Repeaters

by Charles D. LaFond

ANAHEIM, CALIF.—The ever widening encroachment of transistors upon traditional electron tube domains is being felt more and more even by the staid telephone field. Most recent victim is the small telephone repeater or amplifier used to build up voice signals.

As part of a campaign to modernize its communication systems around the world, the Air Force is installing thousands of the new Model 453A transistorized repeaters developed and produced by Altec Lansing Corp., to replace existing vacuum-tube amplifiers. One thousand of the compact devices were recently installed by ITT-Kellogg at Vandenberg AFB for its central inter-site communications network.

While military use is on the increase, there is also a growing acceptance of the unit by public utilities throughout the country.

Application potential for such a device on a worldwide basis is staggering.

- **Vacuum-tube limitations**—Telephone repeaters, in vacuum-tube versions, have been available for some time to build up the voice signal in telephone systems. But these vacuum tube amplifiers have several drawbacks limiting their broad usage. Power requirements are somewhat complex and heat generation becomes a problem when several hundred are ganged together.

A logical solution to these problems is the use of transistors in the repeaters.

Altec Lansing foresaw the need for solid state repeaters, and several years ago initiated design work on several versions. The amplifiers that resulted from this development appear to have proved superior to tube equivalents.

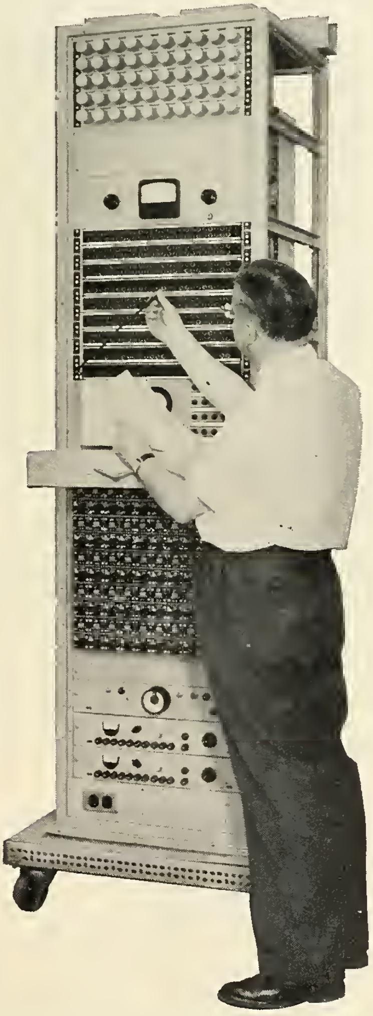
- **Transistor-type characteristics**—The repeaters themselves measure only 1¾ inches square by 6 inches in depth. Each unit is equipped with an eleven-pin plug to replace directly tube-type amplifiers.

The Altec 453A amplifier, is a two-stage negative feedback telephone repeater that operates from a 24-volt central office, a local battery, or a power supply unit available from Altec.

Since vacuum-tube repeaters need a relatively high plate voltage to operate, installations using this equipment must have a source of 130 volts DC. This power is usually supplied from batteries or by a DC generator set—expensive items to purchase and maintain. In addition, the vacuum tube amplifiers require 24 or 48 volts to operate the heaters.

In contrast, the transistorized repeater can be operated with only a 24- or 48-volt supply, eliminating the need for the 130-volt source.

This represents an initial savings of a minimum of $1,000.00 for an acceptable power supply.



TERMINATION BAYS, holding up to 75 transistorized telephone repeaters, are being assembled at Altec-Lansing for the Air Force Aircom program "Quick Fix."

In describing the miniature amplifiers for M/R, Eric Mitchell, senior project engineer at Altec, said the comparative power consumption of the two types also places the transistor unit in a better position. It uses only ½ watt as opposed to 2.5 watts for the vacuum-tube type, said Mitchell.

In single line installations, the heat generation problem is minimal but usually repeaters are installed in large banks, close together because of space limitations. A bank of 100 vacuum tube amplifiers would then generate 250 watts, necessitating some type of correction or forced-air cooling.

This problem is non-existent with the 453A repeater since 100 of them would generate only 50 watts.

In performance, said Mitchell, this amplifier is capable of receiving a full 1-mw input signal set at maximum gain without harmful effects. It is temperature stable and will have a gain decrease of only 0.2 db for a rise from 75°F to 110°F.

If the repeater is used with above-ground wiring in locations of high ambients, such as the desert, the power supply is reduced to 12 volts to assure maximum transistor life.

Amplification is assured, according to Altec, even with wide variations in power supply voltage. A 25% variation is compensated by a negative feedback circuit, stabilizing the gain within 0.3 db.

For dialing, or other DC signal purposes the amplifier can be bypassed by a built-in DC simplex circuit. A maximum current of 100 ma is permitted, said Mitchell, provided the out-of-balance current does not exceed 5 ma.

Besides the need for a compact, reliable repeater at the Vandenberg site, another factor, becoming more prevalent in many other communications systems, enters the picture. As the number of stations or subscribers on a system increases, it becomes necessary to use smaller cable to accommodate new lines and to reduce system installation costs.

At the Vandenberg installation 19-gauge wire previously used will be replaced with 22-gauge or finer, further necessitating the use of the repeaters. The use of cable carrying 22-gauge wire will also result in significant cost savings, attributed to the use of much less copper wire in the new circuits.

At the same time these lines will be switched from 2- to 4-wire circuits to simplify the application of the amplifiers. In addition to improved transmission characteristics available by amplification, the 4-wire circuit affords much better balance.

• **First stock sold out**—When tested early this year by Bell Telephone Laboratories, Inc. for Western Electric Co., performance of the new unit was found at least equal to currently used vacuum-tube types. Even more significant, it was found that 18 transistorized units would fit in the space formerly needed for one conventional device.

Early development of the tiny subsystem appears to have given Altec at least a 1-year lead over competitors. Two apparently similar models by other manufacturers were recently tested by Bell. Both were rejected.

Following the successful testing of the Altec repeater, the entire production then available (thought to be a 3 months supply) was purchased by Western Electric.

If the past is any indication of the future, the Altec repeater shows great promise as a high production item. ⁑

Lockheed Develops Real-time TV Observation for Vehicles

REAL-TIME TELEVISION observation of missile and satellite performance is now possible both inside and outside the vehicle during flight.

Lockheed Electronics Co., has just developed for the Army a miniaturized television/telemetry system that will be used to monitor the operation of subsystems within a space vehicle.

Design engineers using the system will be able to view performance during flight from ground monitor stations, and study the same scenes later from motion picture film.

Cost of the camera system is roughly $7500, but its proponents say that the savings which might be achieved through its use are enormous.

The use of television techniques in space research and development is not new, but the means for real-time readout is a significant advancement for the U.S.

(Russian space scientists are believed to have used a similar system to obtain the unusually high-quality photographs of *Sputnik V's* canine passengers.)

• **TV camera highly refined**—Lockheed's Video Telemetering Camera System will be installed inside and outside of missiles and satellites.

Three systems have been delivered to date for test operation and evaluation by the Army. How many might be used on a given test flight would of course depend on the number of operating functions to be observed, and on available power.

When employed within a space vehicle, cameras will require a light source; but because of the system's fine sensitivity this source need not be strong (thus minimizing extra power requirements).

Fully transistorized, the three-package battery-operated system is lightweight and extremely compact. The 2-lb. camera itself is 7.75 in. long by 2.5 in. dia. Its control unit and sync generator are housed in a book-size container occupying 70 cu. in. and weighing only 2.6 lbs. A 20-oz. power supply is even smaller—less than 17 cu. in.

VIDEO TELEMETERING camera system developed by Lockheed Electronics Co. will employ this 2-lb. TV camera to observe subsystem performance in spacecraft during flight. A special wideband FM/FM transmitter will telemeter data to ground monitors for real-time readout.

The video camera employs a standard 16-mm motion picture lens. Sensitivity of the unit, says Lockheed, is 5 foot-candles. Power requirement for the video camera system is 6 watts.

• **Wideband telemetry used**—A special FM/FM telemetry system consisting of a transmitter, receiver, converter, and ground monitor have been developed by Lockheed to support the camera system.

The missile-borne, 45-lb. transmitter is housed in a 19-in. cylindrical container, 9 in. in dia.

It is provided with 12 continuous IRIG-selected data channels—3 to 18 and A to E. Bandwidth is 20 mc, operating at a frequency range of either 225-245 mc or 245-265 mc.

Also battery-operated, the transmitter has an output of 5 watts, min., into a 50-ohm resistive load.

Potential uses of the miniature TV system are quite varied. In monitoring missile performance it can be used to view operation of latch mechanisms, missile-stage separation, burners, structural areas and even direct-reading instruments.

It could be used to help check out *Mercury* capsule performance from within. Real time readout offers the next best thing to the actual use of an astronaut but avoids the hazards to which such personnel certainly will be exposed during early trials.

For ground use the system offers similar possibilities. For example, when coupled with a DC-DC converter or AC-DC inverter and a monitor, the whole configuration would comprise a closed-circuit TV system for boresighting radar antennas. It might be similarly employed for short-range missile fire control and antisubmarine warfare detection.

The current system has been unde development for over a year. Although they have not even flight-tested it yet the Lockheed Div. reportedly will have an advanced version of the system completed within the next 12 months. ⁑

Panel Shows Pilot, Craft Condition Simultaneously

A sophisticated display panel tha will instantaneously report the condition of both the pilot and his craf has been designed for the Air Forc Flight Test Center by Internationa Telephone and Telegraph Laboratories

Intended to be monitored by a ground-based flight engineer and fligh surgeon, the system is built for use with high-performance aircraft such a the *X-15*. ITTL says that it may also be used on "other space-type vehicle or man-in-space programs."

The first unit will be ready fo operation early next year at Edward AFB, Calif.

The display console is separate into two units, Vehicular and Physiological, each about half the size of an office desk.

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NASA introduces the new

GODDARD Space Flight Center

The Goddard Space Flight Center has just occupied an ultra-modern research complex situated on 550 acres of rolling parkland in Greenbelt, Maryland, a residential suburb of Washington, D.C. Here, many of our scientists and engineers work to advance space science and technology through a broad program of theoretical study, while others design, develop and construct scientific payloads for space vehicles and supervise their launchings. Our technical staff is also concerned with the analysis of space data obtained through Goddard's world-wide tracking and communications network, the nation's center for such activity.

With Tiros, Echo, Pioneers IV and V, Explorer VII, and Project Mercury, Goddard has already written scientific history. Technical men who wish to work in the van of progress are invited to join Goddard or any of the other NASA research centers listed below. Address your inquiry to the Personnel Director.

National Aeronautics and Space Administration

NASA Goddard Space Flight Center, Greenbelt, Md. • NASA Flight Research Center, Edwards, Calif.
NASA George C. Marshall Space Flight Center, Huntsville, Ala. • NASA Wallops Station, Wallops Island, Va.

CREATIVE ELECTRONICS FOR DEFENSE

STRANGE "FISH" UNDER THE POLAR ICE!

Revolutionary RCA Magnetic Video Tape Recorder to Speed Navigation Training of Submari

Aboard the nuclear submarine *Sea Dragon*, the first undersea magnetic video tape recorder will record and store data on under-the-ice characteristics from externally installed TV cameras. Upon return to base the recorded information will be displayed for the benefit of undersea service trainees, greatly increasing their understanding of hazardous polar navigation techniques. The recorder, a joint U.S. Navy-RCA effort, is a marvel of compact design (dimensions: 20″x
100″). It nestles securely in the limited confines
torpedo rack, yet represents a 60 per cent s
reduction over existing commercial video tape eq
ment. Designed to the curvature of the torpedo ra
will fit through the opening of a 24-inch hatch. Tho
small in size, the 4 megacycle recording it prod
is fully compatible with its commercial counterp

g for business—a "video file system"
le of storing an entire encyclopedia on
2½ inch reel, contents of which would
20 billion bits of information!

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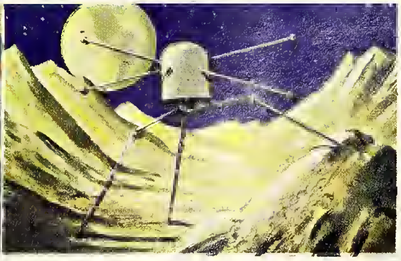

Coming for science—completely unattended recorders, robot-rocketed to the moon, will, on command, provide a detailed "picture" of space, free of the earth's atmosphere!

exclusive RCA recorder developments now contributing to national
include—the "Tiros" satellite recorder, designed for weather observation
r space; a radar recording system to take the first pictures of a nose cone
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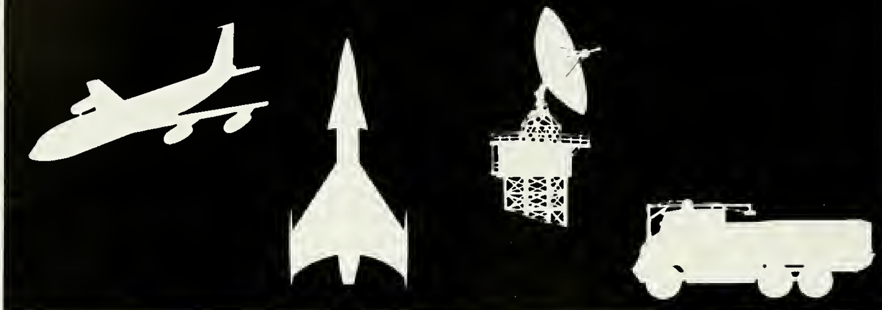

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Glass/plastic Case Has Big Potential

by Donald E. Perry

MAKERS OF SOLID rocket motor cases may realize a multimillion-dollar market potential if they start now to develop techniques for manufacturing monofilament-wound fiberglass cases.

Already, many industry and government observers report, the business to be done in glass/plastic cases exceeds the available production capacity. They say the explanation probably is that very often qualified companies don't even answer requests for quotes.

The demand should be even greater in the future, with the trend toward high-performance systems—in ballistic missiles, upper-stage space boosters, and sophisticated military rocket-powered vehicles of all kinds.

As one top project engineer in a Naval laboratory puts it, perhaps exaggeratedly:

"By 1965 you will scarcely see a metal solid rocket motor case in volume production. I am talking about little as well as big motor cases. This isn't only *Polaris* . . ."

Where the monofilament-wound fiberglass cases may not apply—at least, not soon—is in the more pedestrian types of rocketry, such as tactical Chemical Corps rockets (flares, white phosphorus, gas, biologicals) which do not have particularly high-performance requirements but are procured in very large volume (100,000 to 400,000 unit production runs), and tactical bombardment rockets (Army Ordnance).

One big potential field is the sounding rockets used by the U.S. Weather Bureau.

• **Development**—Navy's Special Projects Office, through the Navy Propellant Plant at Cumberland, Md., about a year and a half ago set about financing development of sources of monofilament-wound fiberglass cases for *Polaris'* second stage. Static test firings are set for this month at Aerojet-General's Sacramento facility.

The plant contacted some 58 U.S. irms with a request for expressions of interest in this field. Through process of elimination, about 12 finally came n on the program.

Each of the 12, at Navy expense, were to build a test bottle—about 18-n. nominal diameter, 24-in. overall ength, 35-to-40 mils nominal wallhickness. The bottles were to have a ylindrical center section with nomially hemispherical closures—in fact, double elipse—at either end plus a port at each end. They were to use six pounds of glass or less and be capable of withstanding 550 psi hydro pressure for one minute with no leaks.

'GRANDPAPPY' of the monofilament-wound fiberglass rocket cases is the Altair X248 rocket motor developed by Hercules Powder Co. It's been used in altitude sounding (Javelin I and III, inflatable spheres); space probes, (Pioneer I, Explorer VI, Argo I and II), and to place satellites in orbit (Vanguard III, Pioneer V and Tiros I). Here's how it is attached to Explorer VI.

If test bottles were successfully made and tested, the competing firms were to be given contracts to manufacture a test quantity—about three—of one-third-scale *Polaris* second-stage motor cases, including rubber insulation liner and the integral metal fitments for seven ports forward and five aft.

Heads and cylindrical section had to be wound as one, and lay-ups were required as reinforcing around the ports. These cases were subject to both hydrostatic and hydrodynamic test, and finally to actual static firing tests with high-energy (up to 20% A1 powder added) propellants.

Six companies successfully qualified through all of these tests. They include Aviation Products Division, B. F. Goodrich Co., The Brunswick Corp., U.S. Rubber Corp., Structure Materials Division of Aerojet-General Corp., Young Development Division of Hercules Powder Company, and Black, Syvalls & Bryson, Inc. Garlock Packing Co. now is in process of becoming qualified. The firm is one of the largest suppliers of the rubber liners.

• **High modulus**—These cases are being made of either Owens-Corning or Houze glass with an actual E (modulus of elasticity) of between 4 and 7 million, although some 10 million is claimed for certain units. (This compares with 29 million for steel.) The resin is an epoxy. Mandrels used for winding are either collapsible metal or of the wash-away variety.

Currently, one-third-scale second-stage *Polaris* cases are being procured for between $1500 and $3500 each in small test quantities. Actual orders have been placed with Young Development, Black, Syvalls & Bryson, and B. F. Goodrich.

Navy Propellant Plant has stopped paying the way of companies into the business; their original intention was to create a competitive bidding situation, and they now have it. However, if a company wants to make the test bottles at its own expense, Naval Propellant Plant will supply necessary drawings, conduct tests, and if results are satisfactory, qualify the company.

• **Opening field**—Several factors indicate there will be a major swing to the monofilament-wound fiberglass case. Already a contract has been awarded to Young Development Division of Hercules Powder to provide a monofilament-wound fiberglass case for the third stage of *Minuteman*.

Some observers say there are no technical reasons why later modifications of *Minuteman* should not have glass-plastic cases in the first and second stages. *Minuteman* is suffering from the combined limitations on its guidance accuracy, warhead size and range; plastic cases could provide an appreciable improvement in mass ratio and thus, in payload.

A similar philosophy would apply in *Pershing*. The Army is making noises about sharply upgrading its performance. Monofilament winding is finding its way into other aspects of missile ordnance such as the telescoping launcher for *LAW* (Light Area Weapon—Army), an antitank anti-installation rocket shoulder fired after the fashion of a bazooka.

Most important, Aerojet General's Structure Materials Division has started developing techniques for winding a first-stage case, probably planned for the A-3, 2500-mile range *Polaris*.

The Navy, other than Special Projects, is still sticking to metal cases. There's a good reason for this. Monofilament-wounds have an attractive strength-to-weight ratio, but the Bureau of Naval Weapons is concerned with buckling. ⁂

Test Separates Thor from AbleStar

Aerojet and Douglas engineers demonstrate that Thor guidance is not affected by second-stage build-up

THE PHOTOGRAPHS on these pages are from a sequence taken during *Thor-AbleStar* separation tests conducted by the Spacecraft Division of Aerojet-General Corp., Azusa, Calif.

The purpose of the tests was to determine whether thrust build-up of the second-stage had any effect upon *Thor* guidance and control systems.

In actual operation, the *AbleStar* engine is ignited after burnout of the *Thor* first stage, and prior to second-stage separation. The *AbleStar* vehicle remains attached to the first stage until thrust is obtained sufficient to overcome that of the *Thor's* vernier engines. The tests demonstrated that the build-up of second-stage thrust had no detrimental effects on *Thor* systems.

For the tests, Aerojet engineers used an *AbleStar* propulsion system with reduced tankage, and a *Thor* section consisting of a transition stage (top section with stripes) and an inner stage (middle section with vent holes and the striped bottom section). The vents were needed in order to avoid excessive concentration of heat and gases, which could damage the inner stage. Vents are not part of the normal assembly.

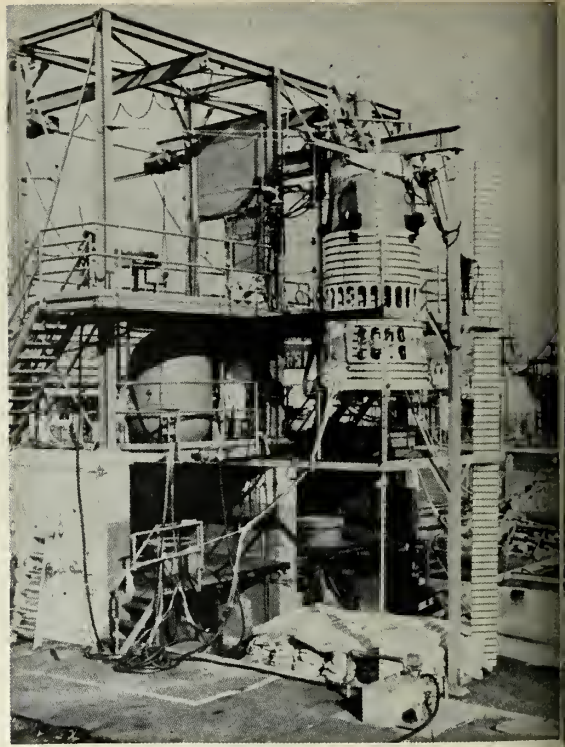
The bottom striped section of the inner stage was fitted with a first-stage fuel tank dome. Steel plates were installed over the dome to simulate the approximate weight of the *Thor* stage at burnout.

Cables were attached to the *Thor* transition section from the second stage. Grid marks (stripes) on the *Thor* sections and on the two vertical boards provided reference points for drop rate calculation from high-speed motion pictures.

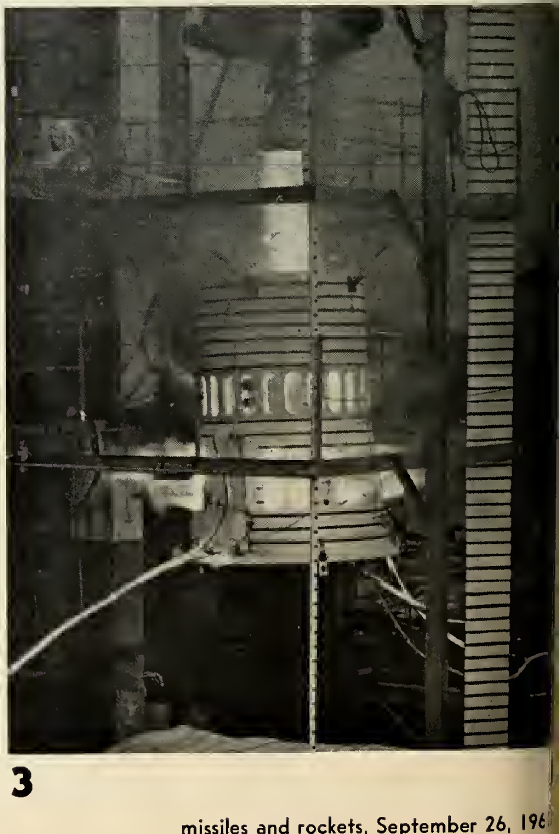
During the tests, *Thor* guidance and control systems were monitored through umbilical harnesses attached to the unit's bottom.

The entire test shown here required only three tenths of a second.

The test was made for the Air Force's Ballistic Missile Division, with Aerojet acting as the test conductor. The *Thor* components were provided by Douglas Aircraft engineers, who also monitored the lower-stage equipment. ⁂



ENGINE UNITS ASSEMBLED on test stand prior to firing. In photo sequence 1-5, 3/10 sec. elapses before Thor lands on mattress.



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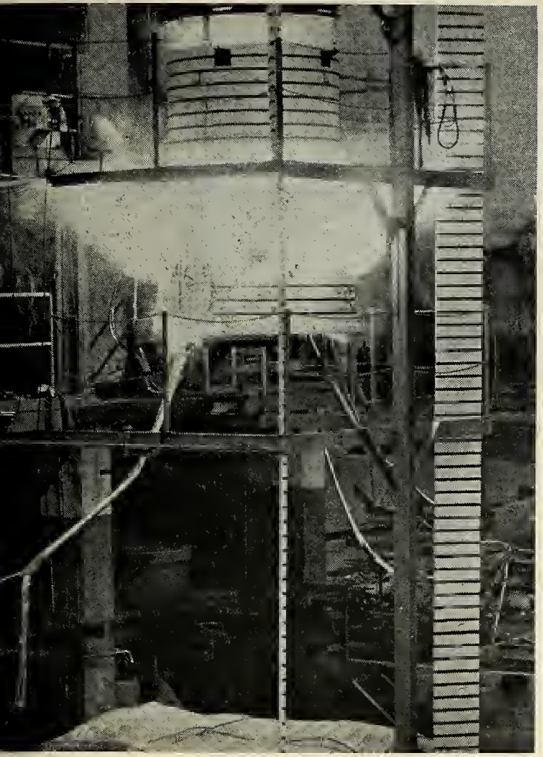

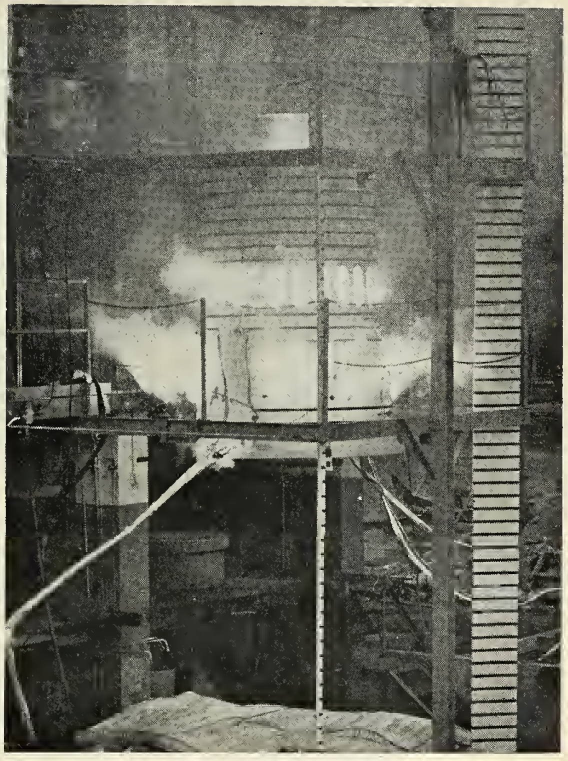

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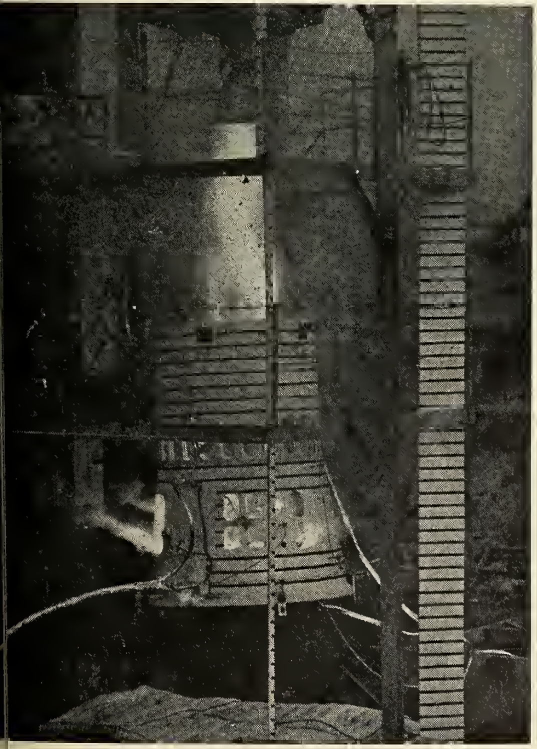
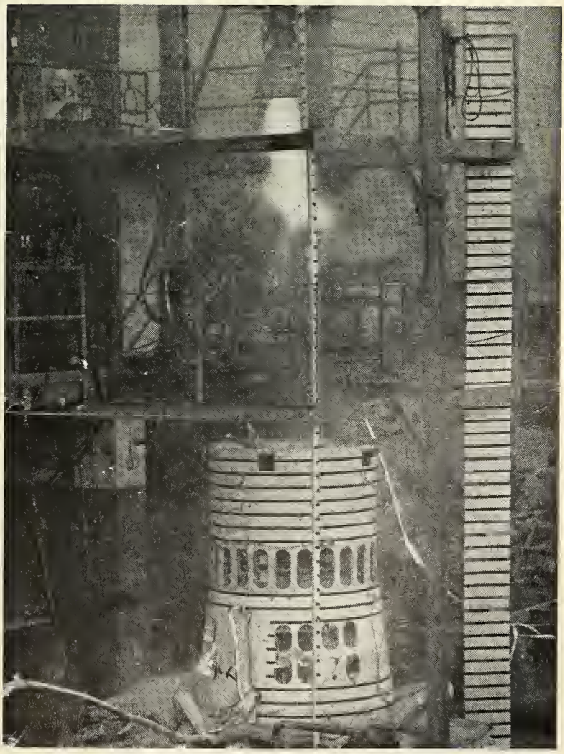




5

Unique Sun Simulator Proposed

Bausch & Lomb system calls for installation of xenon and tungsten lamps in big underground cell to study radiation effects

by Hal Gettings

ROCHESTER, N.Y.—A sun simulator system on the boards at Bausch & Lomb would provide space researchers with a new tool to study the effects of solar radiation on vehicles in outer space.

Using a unique combination of xenon and tungsten lamps, filters, and programed control in a missile test cell, the system is aimed at a stable, efficient, and accurate simulation of the sun's radiation. The basic theory was developed by Dr. Joseph Hall. Photometric measurements made in the test cell would be similar to measurements made in black space.

The simulated sun and earth would have the proper intensity and spectral distribution and the radiation would appear to come from the correct direc
tion. Various relative positions of eart
and sun radiation would be simulate
by controlling intensity and angle o
the light sources and by rotating th
test vehicle.

The system proposed by B&L woul
be installed in an underground test ce
to cover an area of approximately 227
sq. ft.

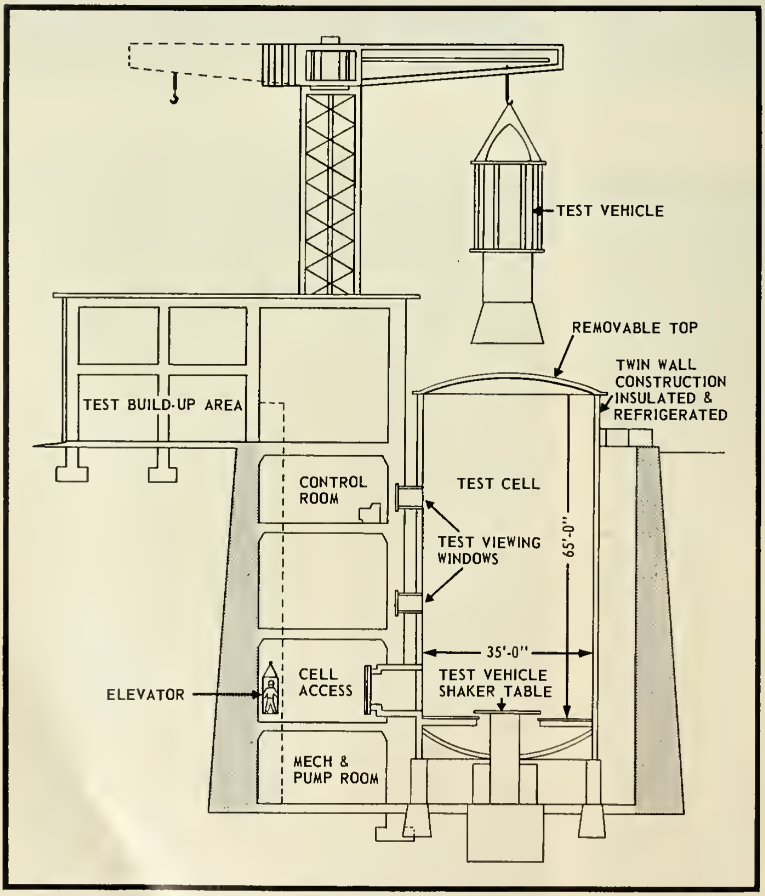
A vibration table in the base, temp
erature controls, the light sources t
simulate the sun's radiation, and a hig
vacuum would provide the neare
earthbound approach yet to the er
vironment to be encountered in oute
space.

• **Sun difficult to duplicate**—Bigge
problem in the design of the simulat
is in duplicating the intensity and wav
length distribution of the sun's radi
tion. Not only direct sunlight must t
considered, but also radiation reflecte
from the earth and its cloud cover i
addition to direct radiation originatir
from the earth and clouds.

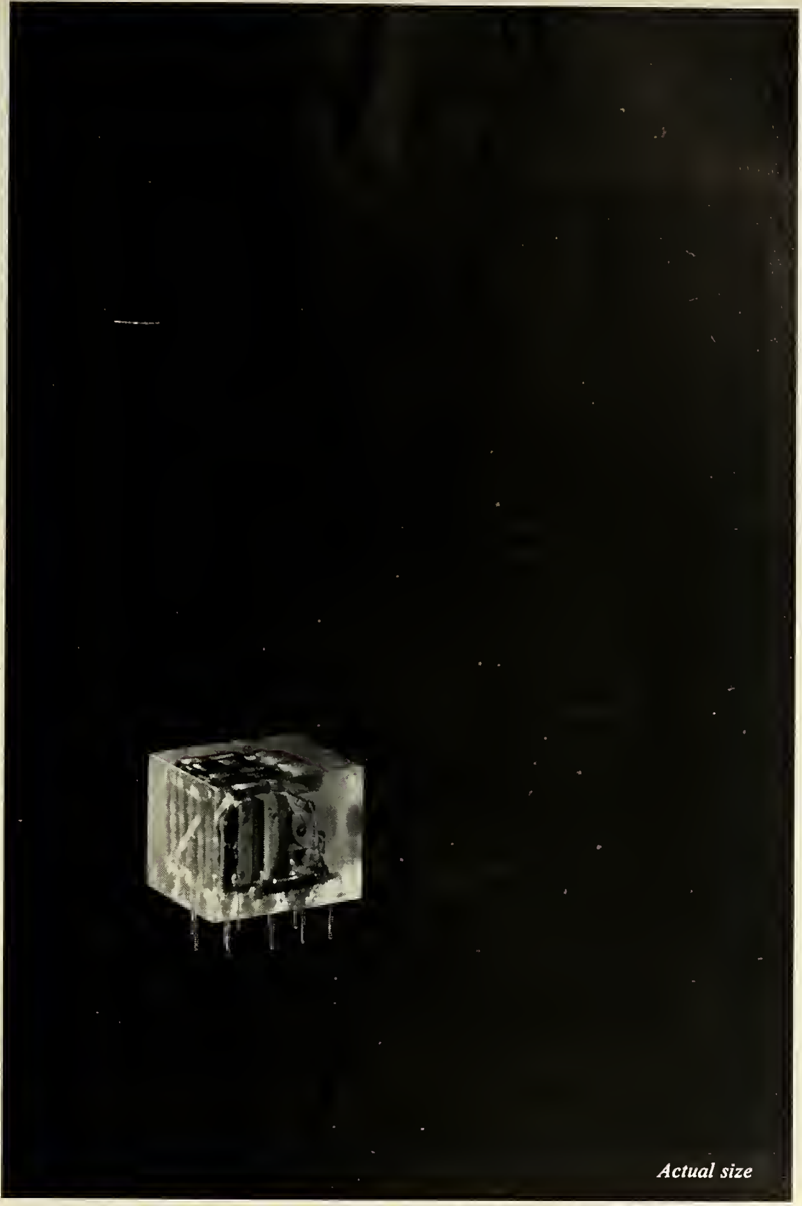
Relative direction of earth and su
radiation would continually change,
would the portions of the space v
hicle's surface exposed to radiatio
Directions and intensities must be a
curately controlled to reasonably sim
late these varying effects. An illumin
tion accuracy of ±5% is the target
the design.

• **Simulation of direct sunlight**
Radiation from xenon and tungsten i
candescent lamps—properly mixed a
filtered—should simulate the spectr
distribution and intensity of the su
Lamps and associated circuitry a
control instrumentation would be l
cated outside the vacuum system f
servicing and to reduce the interr
cooling problem.

The high-intensity radiation wo
be transmitted through small qua
windows in the vacuum chamber. T
diverging radiation within the chamb
would be collimated by modified Fr
nel lenses covering a louvered wall i
side the vacuum chamber wall. T
louvers are small closely stacked tu



SOLAR SIMULATOR in test cell would duplicate direct sunlight as well as both reflected and direct emission from the earth and clouds.



Actual size

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They are *building block modules*. They are a product of Delco Radio's newly developed, three-dimensional packaging technique. They are used to build light, compact, reliable airborne and special purpose digital computers for missile control. Each module, vacuum encapsulated with epoxy resin, contains up to 35 standard components per cubic inch—averaging more than 50,000 per cubic foot. The modules perform all the standard logic functions. They meet or exceed all MIL-E-5272D (ASG) environmental requirements and will operate over a temperature range of −55°C to +71°C. They can be assembled in groups on printed circuit boards. There are 10 basic types and 15 variations of Delco Building Block Modules. With them, Delco Radio can quickly and easily build a compact, reliable computer for airborne guidance or any other military application. For complete details, write to our Sales Department. *Physicists and electronic engineers: Join Delco Radio's search for new and better products through Solid State Physics.*

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LING SYSTEMS USED BY BOEING TO SHAKE DOWN HUMAN FACTORS AND THE MINUTEMAN

Two modern Minutemen—man and missile—advance guards of the space-age, have taken this shattering ride on a Ling Shaker. The Boeing Airplane Company, as prime contractor on the Minuteman Program, is making extensive use of its complete Ling Vibration Systems to test assemblies for the solid-propellent ICBM. In other studies related to human factors, Boeing researchers checked out man's resistance to the punishing 28,000 lb. force of a Ling A249 Shaker—one of the few available shakers of sufficient size and force to make the experiment practical. The Ling system used by the Boeing Aero-Space Division for these tests is one of the largest systems ever built for random-sine wave testing. The installation reflects the emphasis Boeing places on vibration testing as a key factor in reliability. For details on Ling Vibration Systems which can help you to greater testing reliability, please write Dept. MR-6 at our Anaheim address.

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ELECTRONICS

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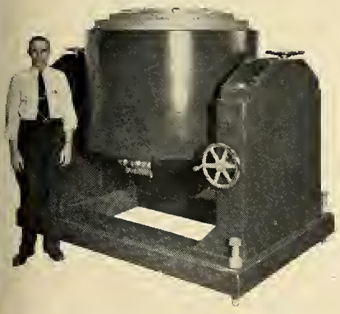
LING ELECTRONICS

The shaker used in the experiment shown at the left is only one part of the large vibration testing installation custom-engineered for Boeing Aero-Space Division by Ling Electronics.

Boeing selected the shaker for its impressive size and high force rating of 28,000 pounds—as well as its advanced closed-loop liquid cooling system. This liquid cooled design employs water and dissipates heat so efficiently that very little heat is dumped on the testing site—a distinct advantage.

In addition to the super-sized shaker, Ling supplied all associated electronics for the extensive Boeing installation—including control console, power supply, noise mixer, equalizer-analyzer, auto-servo systems and all the other equipment needed for complete random-sine wave vibration testing.



The Boeing installation was specifically designed by Ling Electronics to serve the company's needs. Like all Ling systems, it is the result of close cooperation between Ling and its customer. Whatever your own needs in high power electronics—vibration testing, acoustics or sonar—you'll find that you, too, can rely on Ling for practical design.

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HIGH POWER ELECTRONICS FOR
VIBRATION TESTING • ACOUSTICS • SONAR

with the modified Fresnel lens on the end near the wall.

The xenon lamp—which approximates the solar spectrum—supplies the major portion of the artificial sunlight. (Carbon arcs also approximate the spectrum, but due to flickering and constant need of servicing, are not considered adequate.) The xenon lamp is efficient and has an expected life of 1500 hours.

Radiation from the xenon lamp is similar to that of the sun in wavelengths up to about 0.8 micron. Between 0.8 and 1 micron there is a large emission band. Beyond one micron (near-infrared) the emission falls off to zero. A small portion of tungsten incandescent light is added to the xenon to supplement the infrared spectrum.

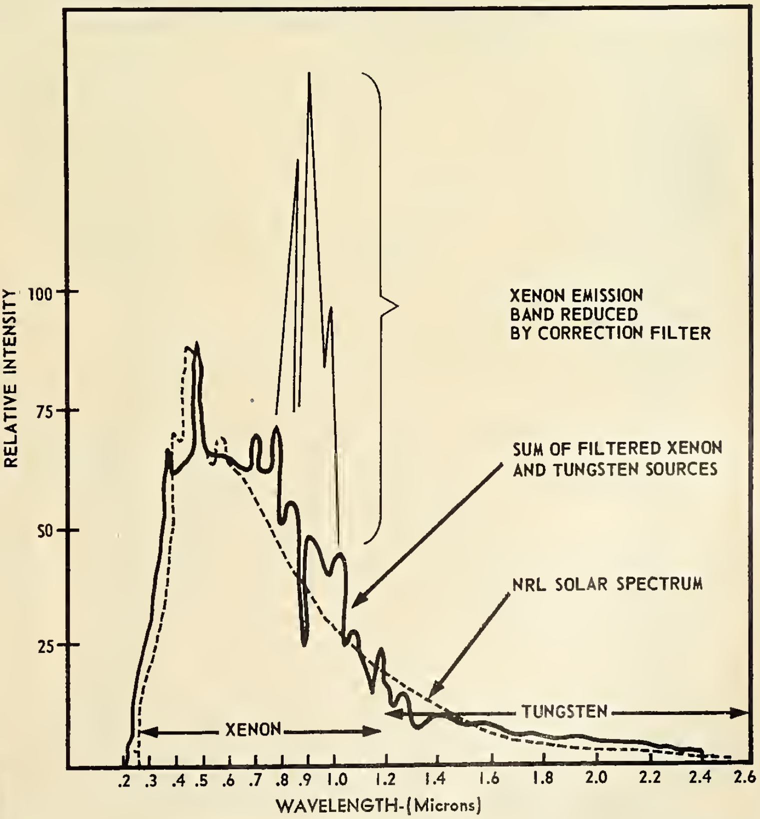
The large xenon emission hand (0.8-1 micron) is reduced and the discrepancy in the tungsten emission corrected by filters to gain a spectral distribution more nearly like that of the sun.

The tungsten source correction filter can be made from anti-reflected silicon and the xenon source filter by using an inhomogeneous layer interference filter.

The radiation output of the xenon lamps may be varied over a 10:1 ratio without changing the color temperature. The illumination will be controlled by a variac on the supply voltage to the xenon lamp. The output of the various lamps will be kept uniform over the test area and with time by photo-electrically monitoring the output light level. The output of each lamp would be kept constant by means of a closed-loop servo driving the control variac.

The illumination output may be varied with time by programing the portion of the output of the photoelectric monitors that is sent to the servo. To decrease the light level, a potentiometer can be mechanically adjusted to send a larger voltage to the servo control to turn down the variac controlling the voltage to the xenon lamp.

The color temperature of an incandescent source changes with temperature, consequently the output of the tungsten source cannot be controlled through the input voltage. However, the output of the tungsten lamp can be varied by a diaphragm whose opening is controlled by the same mechanical



XENON-TUNGSTEN source combination closely matches NRL solar spectrum in relative intensity, spectral distribution. Filters cut emission in 0.8-1 micron range.

double-duty source package . . .

motion that changes the xenon control potentiometer. The entire output of the incandescent and xenon sources could be controlled by means of a diaphragm. However, since the maximum total power consumption of the simulated sun would be about 150 kw, it is considered more economical to control the xenon sources, the major power consumer, by means of the input power.

The orientation of the test vehicle with respect to the sunlight would be determined by rotating the vehicle on its pedestal.

• **Earth simulation**—The radiation from the earth would be simulated by a high-temperature source for the reflected sunlight and a low-temperature source to simulate the earth's emission. The basic high-temperature source and collimating system would be similar to the component used for the sun simulator. This system would be modified to project a rectangular area of light onto the test site. A second unit would be mounted beside the first to project the radiation due to the earth's emission.

Since the reflected radiation is similar in spectral distribution to sunlight, the same radiation source package and control used in the sun simulator would be used in the earth simulation system. The aperture would be altered to enable a rectangular area of illumination to be projected at an angle onto the test area. The intensity of the sources would be adjusted so that the integrated radiation from all the sources onto a test area would simulate the sunlight reflected from the earth.

Each of the seven columns of the earth simulation system would be programed to simulate intensity and relative position with respect to the test site. Various columns can be turned on to simulate relative orientation. For example, a test site located above the earth with an overhead noon sun would be simulated by the fixed sun simulator and a 180° cylindrical sector—using five columns of earth-simulator sources. The earth simulator sector would be on the opposite side of the chamber from the sun simulator. The 180° cylindrical sector would simulate the horizon-to-horizon view the test site would see toward the earth. Similarly, other positions of the earth, with respect to the sun, would be simulated by turning on various portions of the earth simulation system. A distant earth would be simulated by turning on only a small portion of the earth simulator system.

The illuminators in the earth simulation system would be controlled individually or in small groups; consequently, a variety of illumination configurations and intensities would be possible.

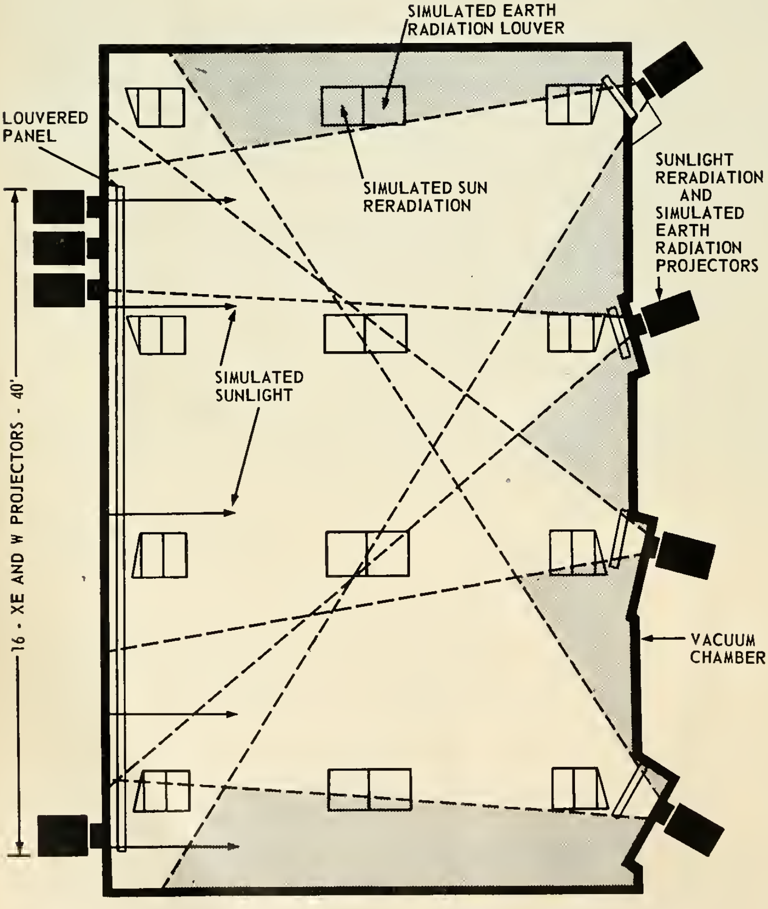
The sources illuminate only a specific test vehicle and not the walls; therefore, the cooling problem is minimized. Sources can be controlled by an automatic program.

• **Thermo-optical radiation cooling**—For removing the generated heat from within the vacuum chamber B&L proposes to use a multiple-stage radiation sink.

This method of radiation cooling separates optically the heat at various wavelengths and removes the heat in the various energy levels—or wavelengths—by means of heat sinks at different temperatures.

Reflected sunlight would be removed from the vacuum chamber by means of the 100°K cooling system and the low-temperature long-wavelength radiation at 4°K. The vacuum chamber walls would be surrounded with glass or fused quartz plates cooled to 4°K. Then sunlight would be transmitted and would not heat the glass. (Glass becomes opaque and has high absorptivity beyond 4 microns. Consequently the glass would absorb the long wavelength radiation.) The transmitted sunlight would be absorbed by the 100°K surface which would have high absorptivity for sunlight, but low tota emissivity at 100°K. Thus the 100°K walls would not radiate energy—due to their higher temperature—to the 4°K walls.

In outer space, the environment is at 0°K and an object would cool to this temperature in the absence of sunlight. In the test chamber with thermo-optical radiation cooling, the environment appears to be at 4°K, and a test vehicle would cool to this temperature. An environment at 4°K is also important for testing various component whose efficiency depends upon prope radiation cooling—such as solar cells. ■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Drugs May Halve Radiation Damage

Army project shows promise of providing protection for humans; NASA watches for possible space applications

by Heather David

CHEMICALS WHICH SOMEDAY may radically reduce the horrors of radiation damage to living organisms are now undergoing limited testing on humans at Walter Reed Army Institute of Research.

Although the compounds are being developed for use by Army combat troops on nuclear battlefields, the new DOD-NASA Aeronautics and Astronautics Coordinating Board is keeping tuned in—for the possible application of such drugs in spaceflight.

The Walter Reed project marks the first time anti-radiation drugs have produced hopeful results in tests on humans, although the idea has been considered since 1950.

A great deal remains to be done. But Dr. David Jacobus and Dr. Michael Dacquisto of Walter Reed are cautiously optimistic that a damage-decreasing "pill" may be possible by mid-1962.

Dr. Jacobus cautions that they could never be a substitute for atomic shelters or shielding. But they may be able to do this: They may reduce the radiation damage of almost any magnitude dose by one-half.

Extensive research with animals has proved this. In tests with humans, cotton saturated with the chemicals was placed inside the cheek of the subject. The entire cheek was irradiated, enough to cause inflammation of the tissues on the inside of the mouth. Dr. Jacobus found that in all cases, if the chemical solution was strong enough, in the treated area damage was reduced by one-half. These patients suffered no side effects from the local use of the drugs.

The compounds with which the Army is working are derivatives of protein-bonding elements found readily in nature. But man could not consume enough in his natural food intake to provide effective radiation protection. Dr. Jacobus likens it to eating a pound of sugar.

When the project began several years ago, some 600 compounds were considered. Many universities and pharmaceutical companies have participated in the testing program, until the field has been narrowed down to 10 likely prospects. These 10 are in the same class of compounds as glutathione, cysteine, mercaptoethylguanidine, and mercaptopropylmine—old acquaintances of the biologist.

- **How do they work?** Four things presumably happen in varying degrees when the chemically-protected cell receives a dose of radiation: a) free radicals are trapped by a lack of oxygen produced by the chemicals, b) formation of free radicals is inhibited, c) proteins are shielded because their energy is syphoned off by combination with the chemicals, d) proteins are shielded because of a change in metabolic activity resulting from combination with the chemicals.

One or more of these reactions may take precedence. But the reaction is linked to living organisms only—the compounds had no effect on plastics.

The greatest problem confronting the Army medical men is the toxicity associated with the use of these drugs. The 10 now being researched are the least toxic of the group, but may produce nausea, hypotension, hyperactivity, and nervous disorders. But as Dr. Jacobus puts it; "We haven't killed anyone yet."

The problem now is to reduce the toxicity and increase the action. Dr. Jacobus' group is experimenting with "activators" or compounds which do not have anti-radiation properties themselves, but may increase the action of those which do.

Two types of compounds are mentioned for this use: methemoglobin producers and cytochrome oxidase inhibitors. These have been successful when combined with the mercaptans.

- **Long term use**—Dr. Jacobus reports that mice have been maintained

How Much Radiation?—Biochemists and Physicists Disagree

There have been some startling discrepancies in adiation measurements taken in important U.S. rocket hots—discrepancies which would mean life or death o space travelers.

In one Army *Jupiter* flight carrying biological amples, the living organisms showed *10 times* as much adiation damage as the physicists' radiation counters ndicated.

NASA Life Sciences radiation experts charge that e biological effects of combined types of radiation—ncluding the possible unknowns—cannot be measured xcept by living organisms.

First, step, says NASA, is to develop an accurate iological damage indicator (BDI) to send on all shots. must be a standardized specimen or organ which ould produce predictable reactions given a certain amount of radiation. A number of things are under consideration, among them a mold spore called neurospora and the mouse testicle.

Neurospora looks the most promising, says NASA's Dr. Dale Smith. When the spore is exposed to radiation the mold will produce a mutation resembling a mothball. By counting the number of these "mothballs," the amount of radiation damage theoretically can be determined. A sample of neurospora was carried on the recent NERV shot.

Very important is the fact that a BDI will show damage from kinds of radiation which might not be recorded on the physicist's instruments. They measure only those kinds of radiation known.

When NASA perfects a BDI, it will be included on every space vehicle the U.S. sends aloft.

on the drugs for one month with no accumulated ill effects. However, the Food and Drug Administration requires an eight-month period of continual use by humans to prove they are safe.

Doses can be designed for almost any length of protection—one hour or up to 24 if desired. Since the compounds are so prevalent in nature, they are inexpensive to produce.

Some work along the same lines has been done at the Dept. of Radiobiology at the Air Force School of Aviation Medicine. The group was able to extend the life of monkeys by giving them aminoethylisothioronium combined with cysteine before radiation. But in all cases, the monkeys eventually died. The Walter Reed group has since given SAM their compounds for evaluation in their program.

Dr. Manfred E. Clynes and Dr. Nathan S. Kline of Rockland State Hospital have projected the idea of drugs, and have come up with a working plan for space. In their paper "Drugs, Space and Cybernetics," they describe a Cyborg, a man-machine system. A servo-mechanism would signal an increase in radiation count, and trigger the administration of anti-radiation drugs. This would leave the pilot free to perform his normal tasks.

But these authors' assumption was based upon the SAM paper—not on any proven chemical compound.

• **Hibernation a possibility**—Much thought recently has been given to the possibilities of hibernating a man during the long uneventful periods of space travel. Body temperature would be reduced to less than 20°C.

There is one study underway to determine whether there is any unusual resistance to radiation in the hibernated state, according to a state-of-the-art survey by Medical Nuclear Consultants of Washington, D.C.

Although details of these experiments have not been published, the survey disclosed that hibernated rats survived a dose of X-radiation which killed the control animals. And 25% of the hibernated animals survived three times as much radiation than did the control animals. The work is expected to be extended to higher mammals—dogs, then monkeys, and with other kinds of radiation.

The Atomic Energy Commission has let a number of contracts on the study of bone marrow as a combatant against radiation injury. Other studies have involved the use of spleen and liver extracts. No conclusive results of effectiveness against whole-body radiation in humans, especially for space-flight purposes, has been reported.

The National Aeronautics and Space Administration is not actively going into the field of chemical protection. Dr. G. Dale Smith, radiation expert on the Life Sciences staff, points out that NASA's prime interest is to learn more about radiation in space—not only the extent and kinds, but the biological effects.

So NASA only looks over the shoulder of those who are doing chemical experimentation in the field of radiation protection. When NASA can determine what biological damages may occur (which may take years), then it may be in a buying position for chemi-protectors, if they are still feasible.

We may find that in the next few years that there are types of radiation from which no drug or shield can protect. Dr. Jacobus' compounds could protect from gamma rays and protons. Nothing has been developed that can shield heavy cosmic particles which might knock out the space ship by sheer energy alone. And there are the unknowns.

• **Outlook**—It's very unlikely that the first manned flight, or even "animaled" flight into deep space will be made until the lowest point in the solar flare period. This will come roughly in 1965 and again in 1976—which would presumably be the first feasible time. In the preparatory years very intensive data will be gathered about radiation in space and what we can expect from it.

It may change all plans for shielding, for chemical protection. It may evolve new drugs. But all agree that the Walter Reed type of research is well worth watching. #

NERV to Report on Radiation Belts

First launch of nuclear emulsion is completely successful and frees extra vehicles for additional experiments

DATA ON RADIATION LEVELS to be encountered in manned flight through the Van Allen belts is due in three to four weeks from last Monday's completely successful first launching of the NERV nuclear emulsion.

In its first flight test, from Pt. Arguello, Calif., a four-stage Aerolab *Argo D-8* solid rocket lifted the 83-lb. package 1200 miles into space to impact 1200 miles downrange, within six miles of the predicted area. It was recovered from the Pacific by the destroyer USS Rowan.

Three more *Argo D-8* vehicles, on hand for backup, now are available for other experiments.

The NERV package (M/R, Aug. 15, p. 30), put together by the Missile and Space Vehicle Department of General Electric, carried an exposable nuclear emulsion designed to record any particle with five million or more electron volts of energy (5 Mev), which penetrated a tungsten shield. "Tracks" in the emulsion produce a permanent record of the number of particles entering, their charge, mass, velocity and direction of travel.

Ilford Ltd. of London, England, is the only company in the Western world producing the material, which has been used for many years in balloon-borne investigations of the upper atmosphere. Because of its thickness, the emulsion takes two weeks to develop. Another two weeks will be required for study of the results.

• **Other experiments**—Although the primary purpose of the experiment was to measure the inner Van Allen belt, the probe also carried three unshielded packages of neurospora. This experiment, designed by Florida State University, will gauge possible mutation effect on the spora due to exposure to the radiation.

Another experiment, removed at the last moment to avoid complications, would have measured micrometeorite density. It consisted of a finely polished lucite shield, on which craters would be examined to determine the velocity and mass of micrometeorites encountered.

Argo D-8, 62 ft. tall, has a first stage consisting of a Thiokol *Sergeant* rocket with two additional Thiokol *Recruits*. Second and third stages are the Grand Central *Lance*, and the final is the Hercules Powder Co. *Altair*.

Flight took about 37 minutes About 115 seconds after lift, at 30 miles altitude, the emulsion moved ou of the container and remained extended for about 25 minutes, throug apogee and down to about 600 miles

The recovery vehicle separated fron the fourth stage a few seconds later Made of Aluminum with an ablatio heat shield, the vehicle was designed t give aerodynamic stability during reentry. At about 40,000 ft., gravit loads activated a pyrotechnic time which fired a mortar and deployed parachute and ejected radar chaff.

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Laboratory studies in antennas and electromagnetic propagation include the application of solid state materials to microwave transmission line component and parametric circuits; the design of antennas to survive the rigors of space flight; and the effects of scattering from missile and space vehicle structures.

Research is also being conducted in the application of MASERS; on problems of radio transmission between space vehicles and Earth; effects of reentry ionization on radio transmission and reception; and development of antennas for data link systems between satellites and ground stations.

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mergers and expansions

GENERAL ELECTRIC CO. has started operation in its new $11-million Lexan polycarbonate resins production plant. The Ohio River plant can initially produce in excess of five million pounds of Lexan a year, but GE officials report that this can be doubled within a relatively short time.

AMERICAN SOCIETY FOR METALS has dedicated its national headquarters in Geauga County, near Cleveland.

LYTLE CORP. has opened its 10th office, this one at Oklahoma City, Okla. The office is under the administrative direction of C. J. Donnelly, manager and vice-president of the Albuquerque division. William T. Gosnell has been named acting branch manager.

CORNING GLASS WORKS has begun construction of a pilot plant on a 400-acre research and engineering center three miles west of company headquarters at Corning, N.Y. The two-story, 93,500-sq.-ft. plant will be first in a series of new buildings planned over the next five years.

ZIRCONIUM CORP. of America announced a change of ownership by which control was relinquished by the Oliver Tyrone Corp., Pittsburgh. The new ownership is reported to include substantial outside interests and greatly increased employee participation, with the former owners retaining a strong minority interest.

PENDAR INC., designers and manufacturers of illuminated push-button panel and console switch-light combinations, have sold a substantial interest in their company to American Technology Corp. The sale was made to augment working capital and to provide additional management direction. C. E. Fisher remains as president, with Ernest M. Lever, Walter H. Trumball, and H. Grant Theis also on the board of directors.

RADIO CORP. OF AMERICA's new Mountaintop, Pa., plant has started pilot production of transistors, with full-scale operations to start soon. The Wilkes-Barre area plant contains 120,000 sq. feet of floor area.

AEROJET-GENERAL CORP. has purchased a controlling interest in Space Electronics, Inc., a Glendale, Calif. subsidiary of Pacific Automation Products, Inc. Percentage of stock and purchase price involved was not disclosed. James O. Fletcher, president, and Frank W. Lehan, VP, will continue in their present capacities. The SEI board of directors will include Fletcher and Lenan, plus Dan A. Kimball, Arthur H. Rude, W. E. Zisch, W. L. Rogers and R. I. McKenzie. Space Electronics just completed a 15,000-sq.-ft. addition to its facilities.

ROCKETDYNE will consolidate a major portion of its present laboratories at Canoga Park into a single laboratory organization in the Vanowen facility. At the same time a new group, the Materials Laboratory, has been established within the Development Laboratory section. Equipment and laboratory personnel of Materials Engineering and PDL laboratories have been combined into the new Materials Laboratory.

MARQUARDT CORP. has realigned its Power Systems Group to integrate its sales activities with its divisional engineering functions. Marketing activities have been decentralized to serve engineering divisions in support of specific project operations. The company also established a new special engines division and a combined Manufacturing and Materiel Division.

ALCOA has acquired the foreign rights to sell and license the manufacture of Sonobond ultrasonic metals joining equipment produced by Aeroprojects, Inc., of West Chester, Pa. Marketed under the trade name Sonoweld, Sonobraze and Sonosolder, the joining tools are used to weld, braze and solder metals by application of ultra-high frequency vibrations.

financial

American Electronics—Net sales totaled $13.4 million for the six months ending June 30, compared with the previous year's first-half sales of $8.7 million. Net income for the period rose to $264,991 from $226,406.

Litton Industries—Net earnings of approximately $7.5 million were reported for the fiscal year ending July 31, as compared to almost $5 million the previous year. Sales totaled approximately $185 million, against $125 million in FY 1959.

Telecomputing Corp.—Reported record sales of $38.2 million for the nine months ending July 31. Sales for the same period a year ago amounted to $28.5 million. Earnings for thr
quarters declined to $417,955 as con
pared to income figures reported
1959 of $1.4 million. Reduced earnin
were partially charged to $1.5 millio
in engineering and development e
penditures for the nine-month period.

Non-linear Systems, Inc.—A reco
$4.9 million in sales was reported f
the fiscal year ending Aug. 31—an i
crease of 80% over the previous yea
total of $2.7 million. President Andre
F. Kay reported that during this peri
NLS captured more than 50% of t
precision digital voltmeter market
both dollar volume and number
units sold. Anticipating another dou
ling in the current year, the firm e
pects to add an additional 135-175 en
ployees. Construction will begin in 19
on six 10,000-sq.-ft. buildings on sev
of the company's 100 acres at Del M
Calif.

Gertsch Products, Inc.—A 27%
crease in sales for the fiscal year end
June 30 was listed by the compa
Sales were $2.9 million, compared w
$2.3 million in FY 1959. Net earnir
were $160,710, a drop from 195
$201,085. The company made an
gineering reinvestment of 61 cents
share during the year, doubling
engineering effort.

Automation Industries—A 24%
crease in sales was reported for the
months ended June 30, 1960. Cons
dated sales for the first half were $
million, with earnings at $153,364.

Electro-Tec Corp.—Substantial ga
in sales and earnings for the f
quarter ending July 31, 1960 w
reported. Net sales reached $1.3 n
lion, an increase of nearly 34% o
975,514 in the same period last ye
Net income rose 66% to $54,3
against $32,835 a year ago. Curr
quarterly earnings is a consolida
total reflecting three months' integra
operation with a recently-acquired s
sidiary—Lambros Precious Metals C
now Precimet Laboratories, Inc.

Control Data Corp.—Sales for
fiscal year ending June 30 rose to
million 111% over the 1959 total
$4.6 million. Net income was $551,6
or 95% over 1959 earnings
$283,214.

Zero Mfg. Corp. net sales w
$5.4 million, compared with almost
million the previous year. Net inc
was $349,460, topping the previ
year's $296,929.

MATRA-Mirage: An All-French System

Highly successful marriage of Falcon-like bird to top French fighter could lead to standardized NATO air-to-air missile

by Bernard Poirier

THE MIRAGE III deployment of *TRA R. 530* missiles promises to one of the finest Western airborne sile systems developed by European ineers.

The *MATRA R. 530* air-to-air mis- has been successfully fired against ecially boosted" Mach 3 drones. missile can be carried by Vautour Mirage III aircraft.

The Mirage III is the French Air ce's Mach 2 attack/fighter all- ther aircraft made by Général Aéro- tique Marcel Dassault.

France's new *MATRA* missile is ly a second-generation *R. 511* which been in production for over ear at MATRA's Engins Spéciaux rmements Aéronautiques Division.

• **Bird resembles Falcon**—The *R.* has homing guidance in two ver- s—one electromagnetic, the other ared. The solid-fuel two-stage mis- with delta cruciform wings looks much like several GAR versions of USAF *Falcons.*

However, unlike the *Falcon* the *R.* apparently has the same classified st/guidance control as other French cal missiles and therefore has no dynamic surface controls or re- or areas.

It is believed that the Mach 2.17 age III can now take off in 2500 climb to 60,000 ft. in 6 mins. with ll armament load—or go higher to maximum serviceable ceiling of 00 ft.—launch a *530* missile at SF radar-located enemy aircraft, hit it about 10 miles away.

This aircraft is pretty much Das- 's prime offering; it may yet be ted by other NATO countries. adoption of MATRA's new missile help to bring about a standard- all-European-fabricated air-to-air le system.

One of the biggest arguments ad- ed by aircraft and missile makers otential NATO buyers has been esirability of standardization. But eaning of standardization is about aried as the languages within O, and the argument has often ed down before NATO's procrastination in agreeing on a definition.

• **Four major subcontractors**—G. A. M. Dassault's aircraft is equipped with a variable-thrust, liquid-fuel *SEPR 841* rocket booster for faster climbs or extreme altitude performance. It can use both a S.N.E.C.M.A. "Atar" jet engine having a thrust of 13,200 lbs. with afterburner, or a Rolls-Royce "Avon" jet.

The *R. 530* is about 6½ ft. long and its packaged fuel is a Hotchkiss-Brandt development. The system's launching system remains classified—although the radar units are known to serve both tracking and firing missions. The missile's velocity is believed to be better than 1200 ft./sec.

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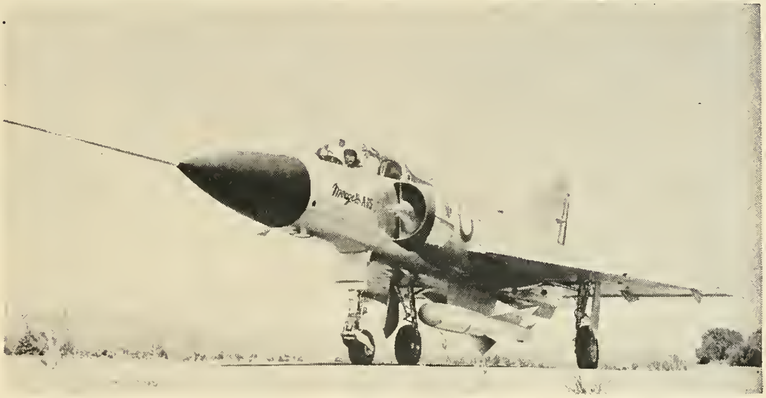
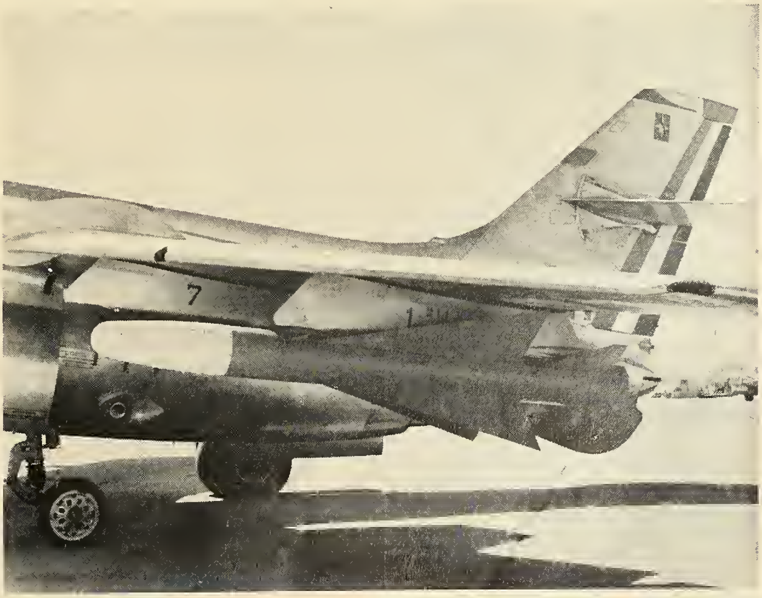


MIRAGE III WITH new MATRA R. 530 air-to-air missile. An exclusive M/R photo.



MATRA R. 530, here mounted on Vautour, has electromagnetic and infrared guidance.

Sperry Gets Navy Contract For Sub Detection System

The Navy awarded a $4.5 million contract for production of a new passive silent underwater detection system for submarines to the Sperry Gyroscope Co.

The system, to be installed in operational subs as well as those under construction, is compatible with existing fire control equipment.

AF Backs GE Plug Nozzle Program with $1 Million

General Electric Co.'s plug-nozzle rocket program is being backed by more than $1 million in Air Force contracts.

The Air Force funding supplements support given by the National Aeronautics and Space Administration. GE will investigate application of the concept to both solid and liquid rockets. Solid rocket studies will be done at the company's Evendale, Ohio, plant, while the liquid rocket work will be done at GE's Malta Test Station near Schenectady, N.Y.

The investigation will include improved methods of controlling direction and magnitude of solid rocket thrust, through varying the throat area of the combustion chambers.

Kurt Berman, manager of liquid rockets at the Malta station, explained that the most distinctive feature of the design is the provision for multiple thrust chambers, rather than nozzle configuration. "It is something like going from a one-cylinder to an eight-cylinder gasoline engine," he remarked.

Research to date has verified all the major advantages claimed for the design, Berman asserted, and GE is very close to the point of proposing its use in a research and development program. He listed these major advantages:

–A plug nozzle acts like an ideal nozzle, with high performance even at low altitudes.

–The engine is half the length of a conventional engine.

–Aerodynamic thrust vector control can be accomplished by varying chamber pressures in the outer chambers and keeping a rigid mounting.

–Stress distribution is simpler since smaller stresses are located at several points instead of one large stress at a central point.

–The manufacture of a large number of small parts instead of a few large parts improves reliability.

The Air Force contracts were awarded by the Directorate of Rocket Propulsion of Air Research & Development Command at Edwards AFB, Calif. NASA has said it expects to spend about $1 million on plug-nozzle research in the current year.

soviet affairs

By Dr. ALBERT PARRY

Desoxyribonucleic acid went into orbit

in ampules aboard the capsule of *Sputnik V* (also known as *Spacecraft II*) and was safely brought back to Soviet soil, along with dog passengers Strelka and Belka. Russian biologists call this acid DNK—after three of the main Russian letters occurring in its full name (K stands for *kislota,* meaning acid).

In an interview published in the Aug. 27 Moscow *Literaturnaya Gazeta,* Dr. Vasily V. Parin, a member of the Soviet Academy of Medical Sciences and a foremost authority on space medicine, stated that DNK is "an acid with an important role in relaying hereditary features from generation to generation." This acid was put aboard the Soviet rocket because "it is of course important for us to know how DNK would react to this outer-space impact."

A high-molecular compound,

the DNK acid is (Professor Parin went on) "by its essence very close to live albumin" and ever-present as a component of cell nuclei. In recent years, he said, scientists have succeeded in "achieving its synthesis *in vitro.*" Observations of its behavior in space-flights will be extremely valuable for manned rocket journeys—when these finally come.

'I don't want to play down the merits

of Belka and Strelka," the Soviet space medicine expert continued, "but, for science, the presence aboard the spaceship of other inhabitants of our planet had a meaning of no lesser significance."

The DNK acid was only one of a number of such "inhabitants" aboard *Sputnik V.* According to Dr. Parin, he and other Soviet scientists "attempted to include in the capsule the earth's animal and plant life in a so-called condensed variation."

Test tubes with bacteriophage, the ultramicroscopic agent which causes the dissolution of certain bacteria, and which Dr. Parin defines as "the simplest of living things" (while other scientists regard it not as a living agent but as an enzyme), were put into the rocket's capsule side by side with test tubes containing "cultures of more highly organized microbes." These were "intestinal bacillus (rod-shaped bacterium), staphilococcus, and actinomyces (ray fungus)—that is, actinomycins producing antibiotics."

Flies of a special variety

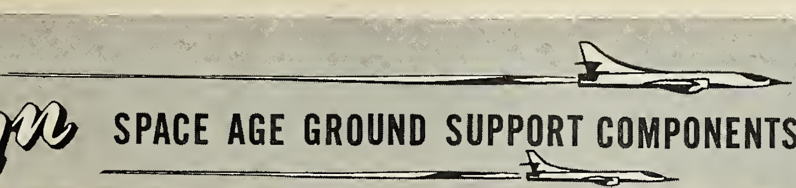
were also included in this momentous rocket flight and successfully brought back, the Soviets say. Drosophila, a genus of flies of the family *Drosophilidae,* was of particular interest in this Soviet experiment. According to Dr. Parin, "this fly has been studied by biologists most closely for many years."

Drosophila is, in the language of biologists, "very plastic," since its succeeding generations "sensitively react to any effects of the outside world to which their ancestors are exposed." (Here, Dr. Parin most likely means the vinegar fly, or *Drosophilidae melanogaster,* which is being extensively used in various countries in laboratory studies of inheritance.)

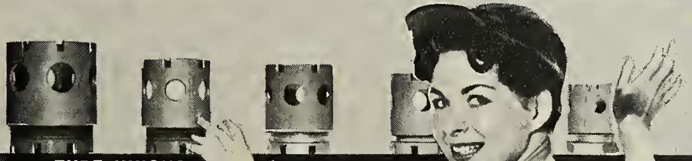
Mice and rats were added

to *Sputnik V's* menagerie, and their presence in the capsule likewise yielded valuable data. "Mice," Dr. Parin remarked to his interviewers, "reach sexual maturity quickly and give plentiful progeny." Hence, he said, the effects of outer-space radiation upon the bone marrow or blood-manufacturing system of mice, or upon the highest nervous activity of rats, can now be studied not alone in those rodents who actually made the *Sputnik V* flight but also in their descendants, to investigate "remote results of this impact."

Rita Roylyn says:



Roylyn SPACE AGE GROUND SUPPORT COMPONENTS ARE SHELF ITEMS



MINI-TORK SWIVEL CONNECTORS

Ball-bearing, pressure balanced, zero leakage at 1 psi to proof pressure. Universal applications.

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TUBE UNIONS

Save time, weight, space. Available from ¼" to 4", built to MIL specifications.

BROCHURE AR-060

DIPSTICKS

Dipsticks accurately scored for precise measuring, and made to quality specifications.

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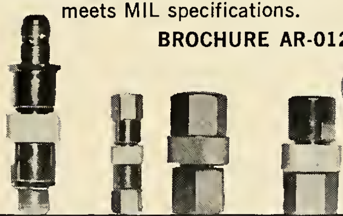
PRESSURE RE-OILING ASSEMBLIES

Two sizes—½" inflow . . . ¾" return flow. Lightweight, rugged, smaller size, safe, positive operation, low stress, meets MIL specifications.

BROCHURE AR-012



AIR-START COUPLINGS

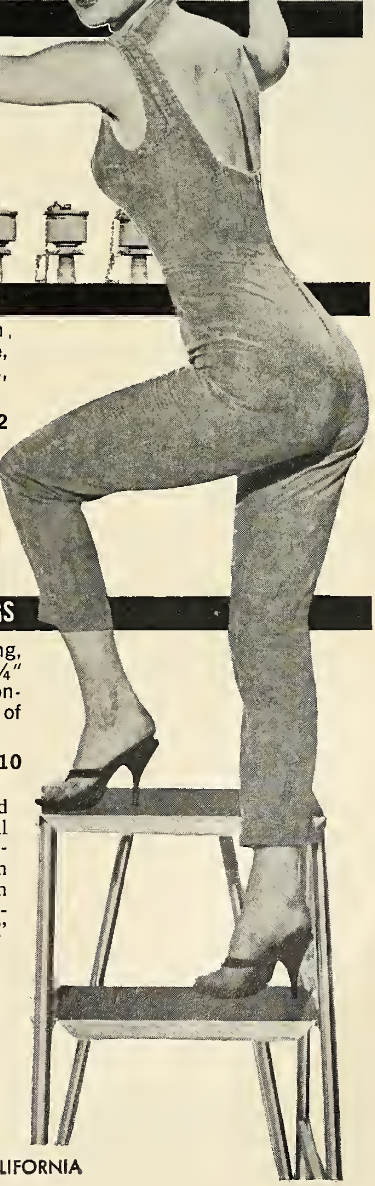
Two models of the brand new Jet-Age Air-Start Couplings. Flange-Adapter and Hose-Adapter models meet every application requirement.

BROCHURE AR-001

OPEN AND SELF-SEALING COUPLINGS

Fast, safe, and sure. Quick-connecting, positive locking, sizes range from ¼" to 6-inch. Couplings are vibration-proof and withstand a wide range of temperatures and pressures.

BROCHURE AR-010



S. A. E. SHOW

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October 12, 13

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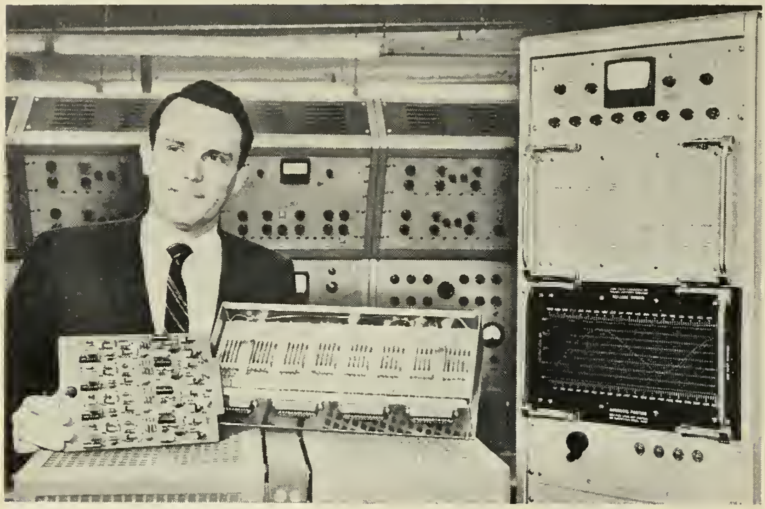


Vibration Test System Equalizer

The first fully automatic spectrum equalizer designed to equalize random motion vibration test systems used in aircraft and missile design and development programs is in production at MB Electronics.

The AE 80/25 automatic spectrum equalizer is geared to completely equalize vibration shaker systems within seconds. Automatic equalization will provide substantial savings in test time and money by completely eliminating set-up time.

The instrument utilizes a multi-band compensation approach. The spectrum is divided into 25 cps increments. Continuous automatic equalization is achieved by using solid-state magnetostrictive filters with correct phase properties plus servo regulators on each of 80 channels in the 15 to 2000 cps spectrum.

Circle No. 225 on Subscriber Service Card.

High-Volt Si Rectifier

High-voltage silicon plug-in rectifiers manufactured by International Rectifier Corp. directly replace Types 8008 and 872A mercury vapor rectifier tubes. By eliminating the filament transformer and time-delay relay necessary to tube operation, they occupy half the space and weigh less than half of equivalent tube circuitry.

Rated at 10,000 volts peak reverse voltage and 1250 ma dc output (at 75°C), the ST-9 and ST-10 are equipped with tube bases to allow direct insertion into existing tube sockets.

Circle No. 226 on Subscriber Service Card.

Reverberation Chamber

An economical, 27-cubic-ft. reverberation chamber to subject missile and aircraft parts to the extremes of noise they meet in use has been produced by PAM Associates, Inc., an affiliate of Tenney Engineering, Inc.

The new PAM chamber generates 150 decibels of acoustic power (linear to 156 db) with a wide band noise siren powered by ordinary shop air supply. A separate air supply is also available. Known as the Stentor 203, the chamber provides random frequency down 5 db at 100 cps avnd 10 db at 10,000 cps, with instantaneous peaks to 155 db.

Circle No. 227 on Subscriber Service Card.

Strip Seam Welder

A utility strip seam welder which can be used in steel mill processing lines already equipped with a shear and other components is on the market from National Electric Welding Machines Co.

Built to specifications, the machine welds clean or galvanized metal up to 48 in. wide and from 16 to 30 gage thick at a speed of 30 fpm on clean stock. Welding power is provided by a 150 kva transformer.

Circle No. 228 on Subscriber Service Card.

Tri-Chambered Freeze Test

A three-chambered low-temperature production processing machine has been introduced by Cincinnati Sub Zero Products. This unit is designed to o increased versatility in production p essing and research testing, by sin taneously providing three separate l temperature liquid refrigerating b operating at the same or different c stant temperatures.

Two chambers can be independe set to operate at any temperature f –70°F to –150°F. The third cham will operate at temperatures f –70°F to –170°F.

Circle No. 229 on Subscriber Service Card

Transistor Thermal Tester

Designed to simplify measureme of transistor and diode temperatu an instrument from Rescon Electro Corp., offers a rapid and foolpr means of making practically all t perature measurements encountered

electronic equipment design. A spe nomograph has been developed wh permits rapid determination of the important transistor and diode junct temperature.

Circle No. 230 on Subscriber Service Car

Constant Flow Regulator

Precise flow regulations of fl even under varying pressures is achie with cartridge flow regulator availa from Fluid Regulators Corp.

The regulator maintains const flow to the system when the pump put or the upstream or downstre pressures vary.

Used in a single body or a m valve manifold, the valve is availa in a wide range of 0.1 gpm to 6.5 g flows.

Circle No. 231 on Subscriber Service Car

capsulating Epoxy

Two semi-flexible epoxy powders eting high heat resistance require- nts for continuous operation in the temperature class have been added the "E" series of insulating resins plied by the Marblette Corp.

Maraset #135E, an unfilled pow- , and Maraset #136E, a filled der, were developed for impreg- ng and encapsulating electrical and tronic equipment including trans- ners, coil windings, and other ts. Both are single-component resins iring no catalyst for hardening.

ircle No. 232 on Subscriber Service Card.

mote Micrometer

Automatic Micrometer measure- its to 10 millionths of an inch can taken by an operator located far y from the actual point of measure- it with the new Remote-Mike avail- from J. W. Dice Co. It consists highly accurate micrometer head rating on the screw thread prin- e, an operator's electronic control sole, plus connecting cable of any th required.

ircle No. 233 on Subscriber Service Card.

sh-Pull Fluid Coupling

A miniature fluid connector especi- suited for electronic cooling appli- ons is being marketed by E. B. gins Oil Tool Company, Inc.

The connector (20 Series model), vailable in size ¼ in. with ¼ in. , and features an automatic push- device for quick connect-discon- operation.

Weighing exactly one ounce, the can withstand pressures up to psi and temperatures from –20°F 400°F. Component parts are in- angeable.

cle No. 234 on Subscriber Service Card.

led Pin Connectors

n extensive line of hermetically d connectors utilizing MS (AN) pin arrangements is available from Deutsch Co.

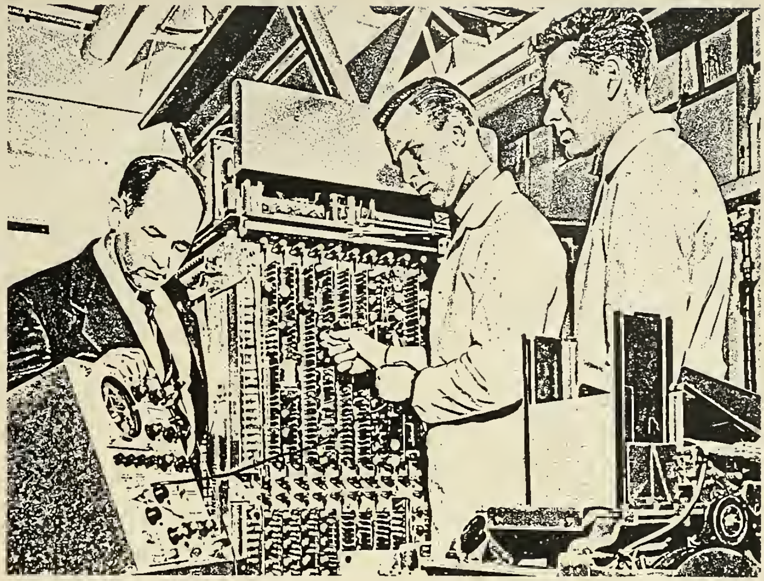
his DH02 line features a full insert ompression glass, providing maxi- dielectric separation and higher ge ratings than comparable con- rs. Contact identification numbers permanently imbedded within the t.

rcle No. 235 on Subscriber Service Card.

stic Film Welder

n ultrasonic technique enabling bonding, threadless stitching, seal- r welding of plastic films and syn- woven or non-woven fabrics has

AT UNIVAC...



An Atmosphere of Achievement

There's a fresh enthusiasm at Remington Rand Univac. The opportunity for personal progress and satisfaction has never been greater. We refer to it as Univac's *Atmosphere of Achievement*—an excellent environment in which engineers and scientists can enjoy unlimited opportunities for professional advancement.

Contributing greatly to this atmosphere are demanding programs involving extraordinary degrees of ultra-reliability. One Univac computer, as example, has logged thousands of hours while maintaining a reliability rating of 99.992 per cent.

Opportunities for participation in creative programs of far-reaching magnitude now exist at Remington Rand Univac. Included among those immediately available are:

DEVELOPMENT ENGINEERS

To develop advanced techniques in high speed memory circuits, switching circuits, and other phases of data processing. Engineers are also required for work on communications systems, antenna couplers, and servo-mechanisms.

SYSTEMS ENGINEERS

Engineering, Mathematics, or Physics degree with experience in weapons and missile guidance systems involving digital control, digital conversion, radar and communications information processing, and input-output equipment.

PHYSICISTS

B.S., M.S., and Ph.D. levels for research and development of systems, high speed circuitry of digital computers, and for physical research including evaporative thin film research and ferro-magnetic domain behavior as applied to computer elements.

RELIABILITY & QUALITY ASSURANCE ENGRS.

To perform reliability analysis and predictions, develop failure reporting procedures, analyze failures, recommend corrective action, set up and implement quality assurance programs.

PRODUCTION ENGINEERS

To plan automated processes, methods and tooling for the world's most reliable computers. These openings on production programs require imagination and creativity. Engineering degree preferred, with experience on electronic equipment.

MECHANICAL ENGINEERS

To design and develop miniature airborne electronic packaging which will meet severe environmental specifications.

OTHER OPENINGS

Mathematicians and Programmers . . . Field Engineers, (Domestic and Overseas Assignments) . . . Engineer Writers . . . Specifications Engineers.

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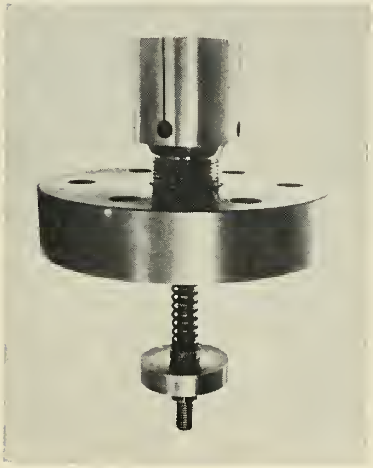
been developed by Ultrasonic Industries Inc. Using only high-frequency sound waves above the human audibility range, this method easily achieves splices or seals. No heat or dielectric currents are used.

Circle No. 236 on Subscriber Service Card.

Expanding Arbor

An inexpensive expanding arbor assembly for greater production results is announced by Craft, Inc., with replaceable arbors for easy machinability.

The assembly consists of a face plate, arbor master and expanding bar. The face plate is attached to the tapered spindle nose by six ⅝-in.-diameter bolts. The taper on the face plate is the American Standard taper of 7° and 7½ in., usually found on most machines.



Circle No. 237 on Subscriber Service Card.

Metal-Composite Laminate

Metal-composite laminated plastics for applications requiring intermittent electrical contact have been developed by Taylor Fibre Co.

With the metal embedded in strong, durable insulation material, the products fill the need for metal-laminate combinations where the more intricate, close-tolerance printed circuits are not required.

Circle No. 238 on Subscriber Service Card.

Miniature Floated Gyro

A series of high-precision miniature floated gyros with a trimmed drift rate of less than 0.01 degrees per hour has been developed by the Reeves Instrument Corp. Identified as the ZERO ONE series, these gyros have an angular momentum of 300,000 c.g.s. units, and a mass unbalance of less than 0.4 degrees/hr/g.

Circle No. 239 on Subscriber Service Card.

new literature

PULSE GENERATOR—A 12-page booklet describing uses and applications of pulse generators, with particular emphasis on high-speed transistorized circuits, is available from Valor Instruments, Inc. The features, advantages and limitations of a new all-solid-state pulse generator designed for use with transistorized circuitry are fully explained in the booklet. The effect of output impedance on pulse shape distortion is illustrated.

Circle No. 200 on Subscriber Service Card.

ALLOY STEELS—A technical data book on the consumable electrode method of vacuum melting super-alloy steels has been published by the Metallurgical Department of Midvale-Heppenstall Co. The book has been written in factual style to supply metallurgists, design engineers and research and development men with the latest data on vacuum melting, the advantages of metals produced by this method and the properties of alloys made by the Midvac Process.

Circle No. 201 on Subscriber Service Card.

SELF-TUNING SONIC CLEANING—A comprehensive guide to ultrasonic cleaning is available from Powertron Ultrasonics Corp. The bulletin provides a basic explanation of how ultrasonics works, what it can do to provide the safest and most consistent cleaning performance, and a guide to selecting the correct tank and generator sizes or console model for the user's needs.

Circle No. 202 on Subscriber Service Card.

FREE SPACE ROOM HANDBOOK—McMillan Industrial Corp. offers a new 12-page report which provides design engineers with a discussion of the many elements of free space room design. Included are charts for estimating room dimensions according to frequency and antenna size, a table of absorber performance, three typical design problems and their solutions, a discussion of specification pitfalls, and a tear-out FSR questionnaire.

Circle No. 203 on Subscriber Service Card.

SILVER-ZINC BATTERIES—A 10-page illustrated brochure on the compact Silvercel secondary batteries has been issued by Yardney Electric Corp. It describes the physical, electrical, and typical application characteristics of these rechargeable silver-zinc batteries, which come in two types: high-rate for complete discharge in less than an hour, and low-rate for discharge rates longer than an hour.

Circle No. 204 on Subscriber Service Card.

RADIATION REFEREN SOURCES—An eight-page broc from Barnes Engineering Co. giv comprehensive outline of the histo development and the scientific pr ples of 'black body' infrared radia It covers fundamental theory, the ous radiation laws, and the curves equations evolved by the major clas scientific contributors to the field.

Circle No. 205 on Subscriber Service Ca

ANALYTICAL STUDIES—A 10- booklet published by AMP Inc., scribes the firm's customer service gram, Creative Analysis. The boo defines the service and graphically i trates the various analytical studies procedures offered to the industry.

Circle No. 206 on Subscriber Service Ca

DESIGNING FOR STABILITY two-part technical article, Incredu Notes #6 & #7, is available from Electronics Co. The first part desc the effects of hysteresis and tempera changes and various open loop met for minimizing these effects. The ciples and general considerations closed loop, bellweather stabliliza are also discussed. The second sec deals with specific closed loop and weather stabilization circuits.

Circle No. 207 on Subscriber Service Car

ELECTRONIC DIGITAL D HANDLING FOR COMMUNI TIONS—A description of equip now available, as well as techniques devices presently in test for accu and speedy flow of information bet the computer and remote station contained in a booklet published Digitronics Corp. Included is a des tion of two types of hardware desi to enable communications to bridge data processing gap. The D300 seri equipment which immediately con information between punched p and magnetic tape in either direct The D500 series provides for trans sion as well as conversion of data.

Circle No. 208 on Subscriber Service Car

COMPUTER CHEMISTRY—A page report available from Comp Systems, Inc. describes a new and r procedure for the "Correlation Optimization of Chemical Kin Models" with the new DYSTAC an computer. A least-mean-squares eva tion of the constants from observed provides the correlation for the m development; the model is then timized to determine the most econo operating conditions. A complete s tion with an accuracy of ±0.1% be obtained for a given process in than three minutes after the data been set in the computer.

Circle No. 209 on Subscriber Service Card

—contracts

NAVY

,0,000—**Sperry Gyroscope Co., Great Neck,** .Y., for production of a new passive lent underwater detection system for ıbmarines.

,0,000—**Bendix Corp.'s Radio Division,** for roviding technical services for the Pacific issile Range.

000—**Bischoff Chemical Corp.'s Riverside** lastics Division, Hicksville, N.Y., for inestigation of plastic materials for use sonar domes.

00—**Thiokol Chemical Corp., Denville,** J., for research and development work the fields of rocket engines for aircraft ıd guided missile propulsion.

ARMY

ey-Moore Associates, a division of ouston Fearless Corp., Torrance, Calif., r rocket tube assembly containers. nount not disclosed.

,025—**Republic Aviation Corp., Mineola,** Y., for drone surveillance systems modcation.

,162—**Fairchild Engine & Airplane** orp.'s Missile Division, Hagerstown, Md., r modification of AN/USD drone surillance system.

,500—**Western Electric Co., Inc., New** ork City, for additional schedule "A" cilities in support of the *Nike-Zeus* proam.

,000—**General Precision, Inc.'s Kearfott** v., Little Falls, N.J., for hydraulic conol systems for use in the *Pershing.* Subntract from The Martin Co.-Orlando.

63—**Chrysler Corp., Detroit,** for engiering services on the *Redstone* missile stem.

44—**Raytheon Co., Waltham, Mass.,** for ncurrent repair parts and replenishnt repair parts for the *Hawk* missile stem. (Two contracts).

41—**Martin Construction Co., Cocoa** ach, Fla., for construction of *Minuten* launch tubes launcher, Cape Canavl Missile Test Annex, Patrick AFB.

18—**Federal Electric Corp., Paramus,** ., for *Nike* technical assistance in supt of simulator station, radar signal, ded missile system.

28—**Douglas Aircraft, Santa Monica,** if., for *Nike* replenishment spare parts. our contracts).

—**RCA Service Co., Camden, N.J.,** for vices and materials required in contion with operation and material of ernment-owned experimental satellite cking station (SPOT).

AIR FORCE

ıter **Equipment Corp.,** Los Angeles, for ivery of a special programable digital e reader. Amount not disclosed.

,000—**Laboratory for Electronics, Inc.,** ton, for continued production of /APN-131 self contained, airborne Dop navigation systems.

358—**Cook Electric Co.'s Advanced** nmunications Engineering Div., Chio, for the intersite communications ems for three *Titan* and *Atlas* missile plexes located in the northwest por of the U.S.

00—**J. W. Fecker Div. of American** ical Co., Southbridge, Mass., for gyro equipment to be used at operational s missile sites. Subcontract from eral Dynamics Corp.'s Convair Astrotics Div.

00—**General Electric Co., Syracuse,** ., for acquisition and tracking ana systems on the *MISTRAM* project.

—**North American Aviation, Inc.,** oga Park, Calif., for depot-level mainnce for propulsion system.

$782,475—**Goodyear Aircraft Corp., Akron,** Ohio, for contractor maintenance and materials for missile weapon system.

$665,600—**North American Aviation, Inc.,** Canoga Park, for installation of rocket engine program facilities.

$392,090—**General Electric Co., Santa Barbara, Calif.,** for applied research on information processing, evaluation and decision-making in complex operational situations.

$275,490—**General Electric Corp., Syracuse,** N.Y., for depot-level maintenance for Model II and Model III IOC phase of guidance subsystem and associated ground support equipment.

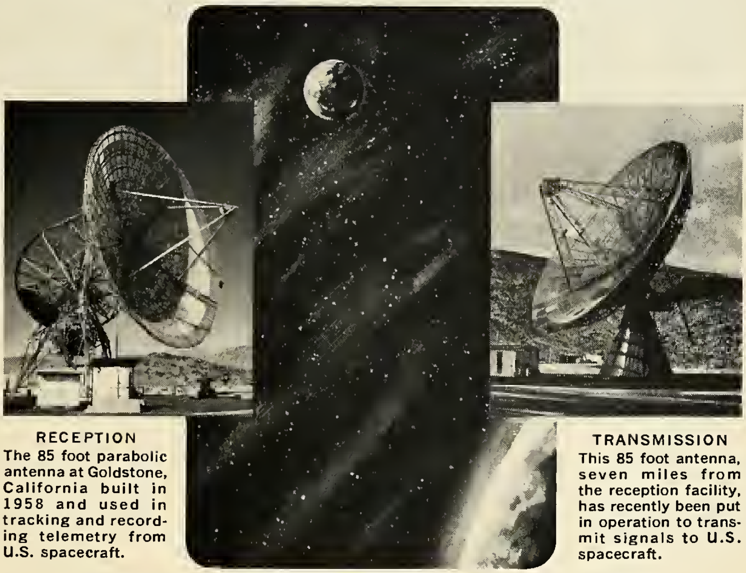
$193,600—**Data Display, Inc., St. Paul, Minn.,** for two high-speed data display systems to be used in current satellite programs. Subcontract from Lockheed's Missile and Space Div.

$180,000—**Consolidated Electrodynamics Corp.'s Datalab Division, Pasadena, Calif.,** for development of a sled-borne magnetic tape system to record the performance of missile components during high-speed tests.

MISCELLANEOUS

$1,300,000—**The Garrett Corp.'s AiResearch Manufacturing Division, Phoenix, Ariz.,** for production of an air turbine generator for the *Quail (GAM-72)* decoy missile.

LUNAR and PLANETARY COMMUNICATION



RECEPTION
The 85 foot parabolic antenna at Goldstone, California built in 1958 and used in tracking and recording telemetry from U.S. spacecraft.

TRANSMISSION
This 85 foot antenna, seven miles from the reception facility, has recently been put in operation to transmit signals to U.S. spacecraft.

SENIOR RESEARCH SPECIALISTS

New opportunities involving advanced research and development projects are now open at JPL in the Laboratory's Telecommunications Division for engineers and scientists capable of assuming a high level of technical responsibility.

SOME SPECIFIC OPENINGS IMMEDIATELY AVAILABLE

Communication Specialists
Execution of RF tracking and communication system projects.

Radio Research Engineers
Design of advanced RF transmitter/receiver equipment.

Antenna Specialists
Analysis, design and evaluation of giant Antenna Structures and Servo Systems.

Research Scientists
Digital data and control system analysis and synthesis.

Mathematicians or Communication System Analysts
Analog and Digital system analysis. Noise, coding, information theory. Linear and non-linear filter theory.

Several openings also exist for supervisors of Research and Advanced Development Projects performed by industry for JPL.

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SEND COMPLETE QUALIFICATION RESUME NOW FOR IMMEDIATE CONSIDERATION

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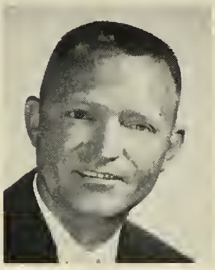
names in the news

EBEL


PHIPPS

BARRON

CIALDELLA

ALLCHIN

Dr. Cataldo Cialdella: Appointed director of research and development at Hysol Corporation; **James P. Hornburg** becomes supervisor of technical services, and **Harry J. Markowski** joins the laboratory staff.

John N. Sherman: Named project superintendent of the newly-created Space Propulsion Dept. of Hercules Powder Co.'s Bacchus Works, responsible for development of solid-propulsion motors for space applications. Was formerly assistant superintendent of the rocket development department of Allegany Ballistics Laboratory.

Dr. Elliott L. Katz: Joins Ford Motor Co.'s Aeronutronic Division as senior staff specialist in Space Technology Operations' Missile Defense Activity. Was formerly head of the Advanced Propulsion Systems Section at The Martin Co.'s Denver Division, where he was responsible for the original efforts on the *Titan II*, *Dyna-Soar* and *Saturn* projects.

P. J. Lawson: Elected to Vactric Limited of London, England, board of directors.

Graham Barr: Joins the engineering staff of Technology Instrument Corp. as a transducer engineer. Was previously with Summers Gyroscope, Statham Instruments and Wyle Laboratories.

Dr. Saul Barron: Former director of research for the Hunter-Bristol Division of Thiokol Chemical Corp., elected director of research for Bell Aerosystems Co.'s newly established research department.

Robert L. Jannen: Former marketing director, becomes assistant vice president heading sales and marketing for the Leach Corporation. Was previously with the Marquardt Corp. prior to joining Leach last year as corporate marketing director.

Dr. Bruce H. Billings and **Dr. David Z. Robinson:** Rejoin Biard-Atomic, Inc., after more than a year's absence on government assignments. Dr. Billings was serving as assistant director of Research and Engineering with the U.S. Department of Defense, and Dr. Robinson with the Office of Naval Research as scientific liaison officer with ONR's London branch.

Richard Allchin: Named president of The Rotor Tool Co., a subsidiary of The Cooper-Bessemer Corp., succeeding **H. P. Bailey,** now chairman of the board.

Philip B. Craighead: Joins Brooks & Perkins, Inc., as manager of their newly formed Military Structures Division.

Louis A. Exner: Promoted to director of contracts for the Propellex Division of Chromalloy Corp., with responsibility for customer relations and advertising.

Ralph V. Barnett: Appointed director of marketing for General Precision, Inc. Was formerly with the Librascope Division as vice president and eastern regional manager.

Robert W. Pike: Elected chief engineer in charge of research and development for Industro Transistor Corp., heading the firm's new Semiconductor Research and Development Center in Natick, Mass. Prior to joining the firm he was Clevite Transistor Products' senior development engineer.

B. William Miller and **Robert G. Evans:** Appointed manager of marketing and manager of prototype fabrication, respectively, for Space Technology Operations in Ford Motor Co.'s Aeronutronic Division.

Stan Burns: Promoted to manager of Engineering Development and Programming, Ground Support Division, American Electronics, Inc. **John R. Clifton** succeeds Burns as director of engineering.

William Kenneth Ebel: Vice president, engineering, of Canadair Ltd. for the past 11 years, named staff executive to the senior vice president for engineering of General Dynamics Corp. He will assist in coordination of engineering activities among all of the firm's divisions and its Canadian subsidiary.

Robert P. Whorf: Appointed manager of Product and Market Planning Services in the newly opened New York office c Auerback Electronics Corp.

John M. Phipps: Named director c marketing for Electosolids Corp. Previou posts: Western regional sales manager fo the Pesco Products Division of Borg Warner Corp.; senior sales engineer fo Meletron Corp.; research analyst fo Northrop Aircraft, and statistical analys with Douglas Aircraft.

P. W. Perdriau: General manager o B. F. Goodrich Aviation Products Division, named president of the company' Industrial Products Co. **Clinton B. McKeown,** general manager of manufacturing, steps up as division general manage

Richard V. Carroll: Senior electroni engineer, promoted to senior applicatio engineer in charge of R-F Instrumentation at Borg-Warner Controls.

Leon L. Berman: Former Army Ordnance Missile Command officer at Frankford Arsenal, joins American Electroni Laboratories, Inc., as Systems Divisio head.

Richard J. Bazard: Datex Corp. seni project engineer, promoted to systems e gineering manager.

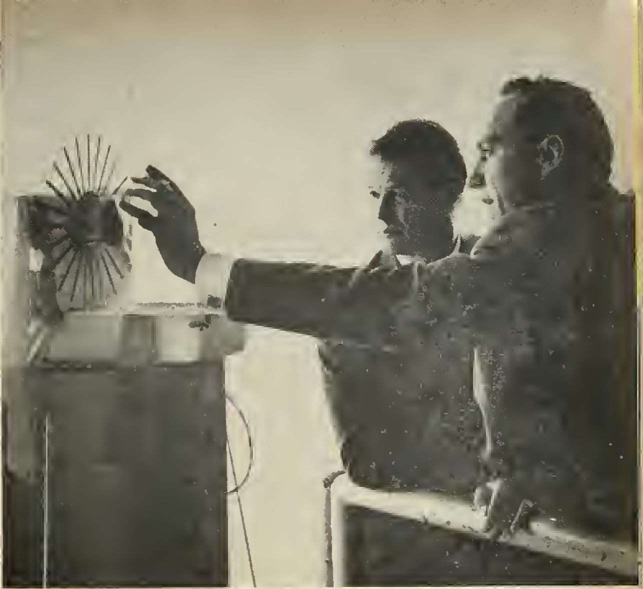
Dr. Zvi Prihar: Former professor electrical engineering at the University Wichita, joins Page Communications E gineers, Inc., as assistant director of tel communications.

J. Gordon Neuberth: Former engine with the Bendix Corp.'s Radio Divisio named vice president and chief engine for Applied Microwave Electronics, In

Dr. Hermann H. Kurzweg: Named a sistant director for Aerodynamics a Flight Mechanics in NASA's office of A vanced Research Programs.

Lt. Gen. Roger M. Ramey (USA ret.): Appointed president of Permane Filter Corp. Was formerly vice preside in charge of district offices for the Nort rop Corp.

Ve find its concise technical/news coverage of the missile and space market ry valuable in keeping up with developments in this rapidly growing field." P. Della-Vedowa, Manager, Quality Assurance and Test Services, Satellite stems, Lockheed Missiles and Space Division.



"I consider M/R an excellent source of information on new advances and applications in the missile/space field. It keeps us abreast of the state of the art in missiles and rockets for a better understanding of advanced requirements in antennas." A. F. Gaetano, Head, Electromagnetic Systems.

VHY DO SO MANY KEY PEOPLE AT LOCKHEED AIRCRAFT READ MISSILES AND ROCKETS?

1,080 PAID SUBSCRIPTIONS! In 1959 Lockheed Aircraft Corp. ranked *third* among all military prime contractors. Its missile and space achievements include the Polaris ballistic missile and the Agena satellite, plus many others. Therefore, it is natural for 1,080 of M/R's paid subscribers to be concentrated in Lockheed. And since many of these MISSILES AND ROCKETS subcriptions have high pass-along readership, there are many mes that number of M/R readers.

Some of the many reasons why M/R commands intense readership at Lockheed are given in the picture story. They were obtained as a result of a recent visit to the company by M/R Executive Editor Clarke Newlon (insert).

These comments and those of other key readers in other missile/space companies clearly show what M/R has known all along . . . that the missile/space industry is a separate, distinct market with requirements which change almost daily . . . a market that can best be interpreted by undiluted, *weekly* technical/news coverage. It is this kind of coverage which makes M/R the leader . . . explains its deep, penetrating readership and acceptance.

The weekly issues of M/R give us fresh coverage . . . not month-old news. litorially it is well written, sprightly and lively." J. L. Shoenhair, Assistant anager, Polaris Missile Section.

"M/R gives us what we want to read in the missile field. There is no waste of time wading through material foreign to our interests." L. H. Amaya, Manager of Lockheed's Digital Computer Operations.

letters

Doubts on Dogs' Recovery

To the Editor:

It is a sad thing. Many free-thinking people in the world are losing their freedom of mind.

From the mouths of a well known foreign power came the words that "we did not shoot innocent people in Hungary." These same mouths said "an RB-47 violated our airspace (and we shot it down)." When forced to prove these claims in the United Nations, that foreign power could not produce.

Now this foreign power says they brought two dogs safely from orbit and everyone goes goofy about it. No proof at all—all they have to do is say "we did it."

They must certainly have captured the minds of free-thinking people when they can get away with something like that.

If you have the fight for it you should devote your columns to challenging the Soviets to prove their feat—and it might also be a good idea to inform them that the free world wants proof of a successful manned space flight. Their launching and recovery should be confirmed by an impartial, international board of scientists.

The attached material may help you understand why I feel that the Soviets have pulled a fast one. I'm not just screaming "sour grapes." I known they launched the first satellite, hit the moon, and took some sort of pictures of the far side of the moon, but this claim stinks to high heaven. For God's sake don't let them get away with these half-truths and lies.

Lewis Dewart
Personnel Dir. & Science Writer
Sunbury Daily Item
Sunbury, Pa.

Reasons for Doubt of Successful Recovery of Satellite from Orbit by Soviet Union Based on Soviet News Releases—

The first conflict in stories on the Soviet "space dogs" showed up when on Aug. 20 *Pravda* reported (while dogs were still in orbit) that they "were feeling fine and eating well." On the 21st, that same news service reported that immediately upon landing, food and medical supplies were rushed to the dogs. It would appear that if the dogs had eaten at least once during the voyage there would be little need to rush to them with food.

Secondly, the report issued after the "landing" and liberation of the dogs sounded as though it came from a dime store novel. The Soviets reported that "specialists . . . were the first to open the ship. Belka and Strelka rushed out of it. They ran about the meadow fawning upon people and barking merrily." This is ridiculous. If blood pressure, heart pulsation and other biomedical measurements were made in flight, the dogs must have had many restraints on their bodies to keep underskin electrodes, etc., from being accidentally torn loose. Also, the dogs would have had to be restrained to protect them from the rigors of blastoff and landing. The TV pictures released by the Soviets showed no such restraints on the forward portion of their bodies. It is doubtful that a wise biomedical researcher would allow his specimens to "dance around the meadow" after such an intricate experiment.

No one knows anything about the experiment except the appearance of the dogs. Also, two days after the "feat" news releases from the Soviets dwindled to practically nothing. This is not customary Soviet behavior after space accomplishments.

Such an accomplishment is worthy of some boasting. But the lack of information leads one to wonder just what happened after all.

Dog-eared But Read

To the Editor:

I am employed as an electronics instructor by RCA Service Co., Inc. here. I of course enjoy every copy of M/R that I can get my hands on, but this electronics section that I work at only has one copy delivered, and it's well filtered by the time it gets down to us. (I think we get it solely through osmosis), but dog-eared as it is, we do like reading it. (A reprint order enclosed.)

Bernard Yudofsky
Aberdeen Proving Grounds, Md.

Preserving 'Alga'

To the Editor:

Now that algae are coming increasingly into astronautical literature as oxygen regenerators for space cabins, would you please insist that your contributors use the word grammatically as the plural of alga, and avoid such illiterate expressions as "algae is pumped . . . " and "algae is mixed . . . ", which appear in your Aug. 29 issue on page 35.

It is already too late to tell any English-speaking technicians that "data" is the plural of "datum," because they just won't believe it. But it may not be too late, in the interests of literacy, to save "alga."

Alan E. Slater, Council Member
British Interplanetary Society
Dell Farm
Whipsnade
Dunstable, Beds.
England

We are caught green-handed in the case of "alga"; we'll try to avoid it in the future. "Datum" and "data" may be a different case; use of the latter with a singular verb is now sanctioned by some authorities—at least, on this side of the Atlantic. We are glad, of course, to receive corrections of the errata that creep(s) into the magazine.—Ed

reviews

ELEMENTARY INTRODUCTION TO NUCLEAR REACTOR PHYSICS, S. E. Liverhant John Wiley & Sons, New York, 447 pp $9.75.

Here is a text that is admirably suited for its designed purpose, teaching undergraduate students the theory of nuclear reactors. Happily, the author eschews the purely qualitative description of nuclear theory and demands that the students have an elementary physics background and a familiarity with the rudiments of mathematics up to differential equations.

The book is easily read without an instructor and therefore is recommended for graduate engineers and scientists who want to gain some familiarity with the nuclear science field.

The book's first three chapters deal with fundamental aspects of nuclear physics. Subsequent chapters deal in logical order with the principle concepts needed to understand the workings of the various nuclear reactors, which are in turn discussed in the closing chapters.

FUEL CELLS, edited by G. J. Young, Reinhold Publishing Corp., New York, 154 pp., $5.75.

This book is based on papers delivered at a symposium on fuel cells held by the Gas and Fuel Chemistry Division of the American Chemical Society in September 1959. The research of some of the contributors to the symposium has, in part, provided the impetus for the renewed activity in a field that up to recent years has received only casual study.

The book covers aspects of the design and principles of operation of various types of fuel cells. The contributors examine the industrial implications of fuel cells as ground power supplies, as power supplies for mobile engines, and as chemical reactors. Avoiding the popularized approach, the book tells with some degree of success where and how fuel cells can be applied today, and under what conditions they may be applied tomorrow and after that.

MAGNETIC AMPLIFIERS, Principles and Applications, Paul Mali, John Rider, Inc., New York, 112 pp., $2.45.

Presuming a fundamental knowledge on the reader's part of electricity, this text starts with a review of the field of magnetism, electromagnetism, and magnetic circuitry. From here, the text carries the reader into the saturable reactor—the heart of this field. Discussed are self-starting and three-legged core magnetic amplifiers, compensating magnetic amplifiers, and variations of these.

The text next goes into amplifier gain, feedback, and general uses and construction. The important topic of maintenance and troubleshooting is covered from a practical viewpoint. A final section on system applications shows diagrammatically a number of practical applications of magnetic amplifier circuitry together with a discussion of each application.

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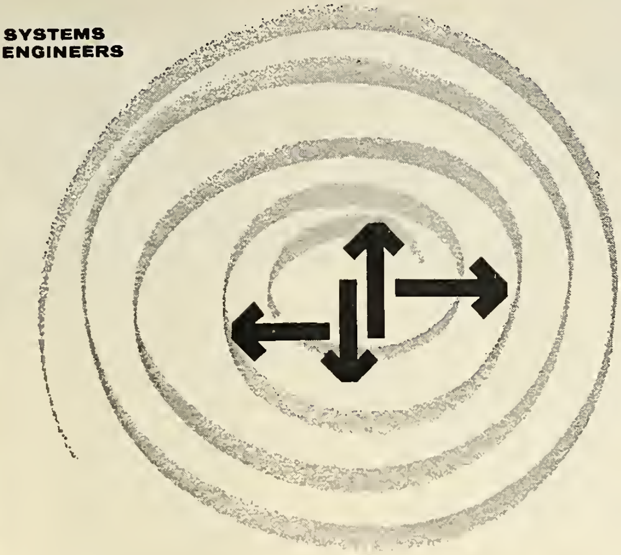

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editorial . . .

The Russians Plan—We Don't

THE IMPACT OF the appearance of Mr. Khrushchev on the American scene this week might serve to bring home forcefully to the citizens of this country, particularly to its leaders, some of the very real facts of life—Russian versus American.

In a little more than 40 years Communism has taken complete economic and military control over one-third of the people of the world—and effectively softened up much of the remainder.

There is little doubt that the Red Chinese-Soviet bloc is matching or excelling us in overall military capacity. Actually, the emergence of Red China as a military power with an even more ruthless dictatorship than Russia's (and three times the population) makes it an even greater threat than the USSR.

Equally threatening, the Russians in recent years have shown a rate of economic growth more than twice that of the United States.

These things the Communists have accomplished starting from a level of knowledge, training, education and experience far lower than ours.

How have they done it? In a large measure, by setting a succession of well-planned goals and making any sacrifice or paying any reward necessary to meet or approach those goals. Their long-range plans have been carried out ruthlessly, with a complete disregard of human rights. Many times these plans have not been carried through to meet all objectives, but the overall progress far exceeded that of any western nation, including the U.S.

This selfsame planning—projection years ahead of the greatest possible economic, military and social strength in the institutions which we have built up over the last 100 years—is sadly lacking in this country.

There have been sporadic attempts to bring in people, on a committee basis and at a national level, to do forward planning.

There was the Gaither Report, the Rockefeller Report and the Draper Report. There have been studies by MIT, by Harvard and by UCLA, all pointing to the absolute necessity for thorough, long-range national planning.

WHAT HAS HAPPENED to them? In a paper prepared for the University of California, C. S. Irvine, industry executive and lieutenant general USAF, retired, says:

"The majority of these reports have been so highly classified that people in government and industry who might find their contents useful have been unable to obtain access to these reports or utilize them for constructive action. They should have been published as feature articles."

Remarking on the effectiveness of Russian planning, General Irvine continues:

"It becomes obvious with the present progressive status of the Soviets and with the upcoming surge of the Chinese, that we should plan for military readiness, economic warfare and spiritual combat for the next 50 years in this country."

The planning necessary for the United States if we are to meet the competition of the East covers almost every aspect of our existence. It should insure a greatly intensified development of national resources, including nuclear energy. It should provide a constantly increasing rate of technological advancement and an increasing rate of automation. It should look forward to revision and modernization of our government operation and our tax structure, and to sociological advances commensurate with our increasing population. It should make allowance for the inevitable changes in our industrial system.

Planning is a natural and a necessary thing. Families, tribes, cities and countries have been doing it for ages. The Russians didn't invent it. One Egyptian Pharaoh did a pretty effective job of planning for the fat and lean years based on nothing more tangible than Joseph's interpretation of his dream. We have a great deal more to work with.

Clarke Newlon

Several new contracts for research and development of computer and guidance components for the Polaris Missile have recently been awarded to the Hughes Engineering Division. As a result, a variety of openings have been created for graduate engineers and scientists who have a minimum of three years experience specifically related to:

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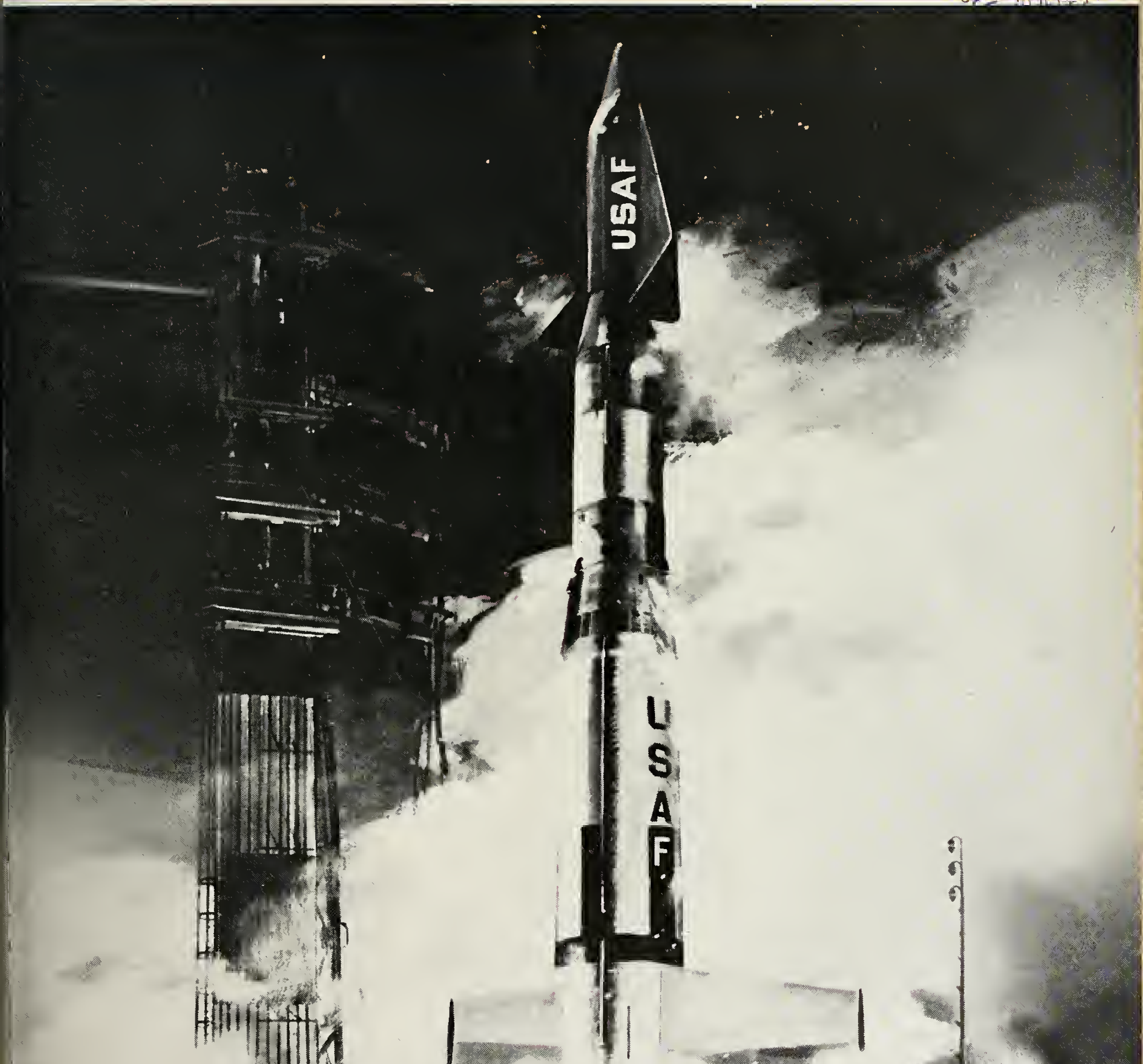

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An Open Letter to:
RCHARD NIXON and JOHN KENNEDY

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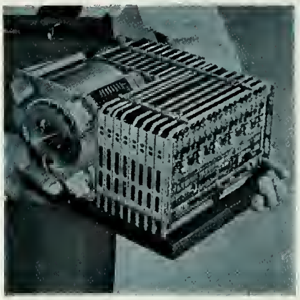

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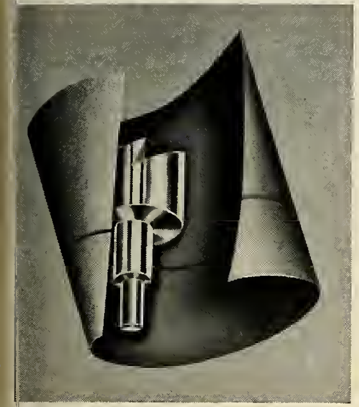

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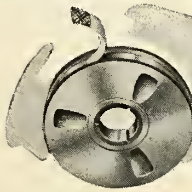

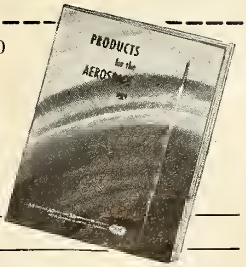

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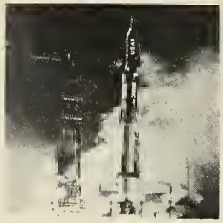

THE COVER

Artist's conception of Dyna-Soar launch atop specially adapted Titan ICBM. Note fins on first stage of booster. First flights are due by 1963. See p. 16.

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letters

Overclassification?

To the Editor:

In the Sept. 5 M/R, COUNTDOWN mentioned that extremely clear color photos were made of a Russian missile warhead on July 7 in the Pacific. These photos were supposedly so clear that the type of material (ablating) used on the re-entry vehicle could be identified.

Why were these photos and the type of material classified by the Pentagon? Are we afraid the Russians will learn what material they are using? Or are we afraid our Western allies may find out?

This sounds to me like the perfect example of the asinine classification of material and withholding of information that goes on every day and in many instances harms the furtherance of technical advancement in many fields by private industry.

There may be a logical explanation and I hope there is. But to the readers of the article I'm sure it sounded ridiculo

I enjoy each and every issue of y fine magazine.

Bob Kietzman
Long Beach, C

Underclassification?

To the Editor:

I enclose a security notice ("O Security Regulations") published by Department of Defense in Washingt D.C., copies of which were recently fo one morning on the desks of all person in the missile plant where I am employ

They were placed there (in g faith) by the plant security group du the off-work hours.

The Sept. 19 issue of M/R had arrived in my mail basket.

I immediately began a quick per of it, as usual, when it fell open to p 41—and behold the map of the U showing all ICBM bases present and p posed, hardened or soft, plus *Polaris* M sile Depot and other missile test cent

How do we reconcile publishing this information with the enclosed noti I realize this was released by Washingt probably published elsewhere, etc., do we *have* to make it easy for the es onage agents of a foreign power? I this carrying "freedom of the press" the *nth* degree? I have been in the mis business several years, but did not alre have all of the information disclosed that map. Our government again sh that amazing *lack of coordination* wh has existed for so many years. Woul this be good material for Kennedy Nixon to chew on in the present ca paign?

It seems to me that "security" in t country will remain a farce as long security positions are passed out as litical plums.

Henry S. Mack
North Wilmington, Mas

Reader Mack is correct—all the formation on the map was released b number of different official agencies. a free country where projects are put to open bids, and anyone can wa through a cornfield with a camera, i impossible to keep the Russians from m ing similar maps. Therefore the gov ment would appear to be right in relea the information for publication so that American people can know, too.—Ed.

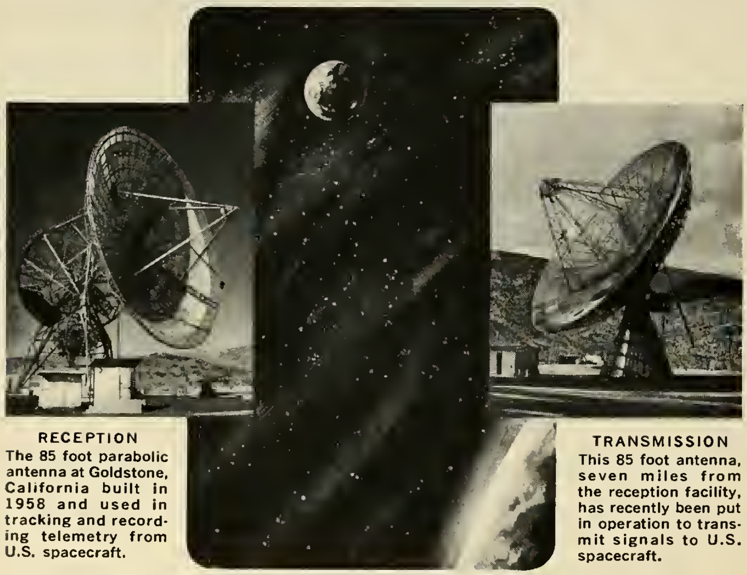
Titan Coverage

To the Editor:

Just a note to tell you what a b up job I thought you did with the sp report on *Titan* in the Sept. 5 issue. Baar's lead-off article was not only moving but quite comprehensive, as the entire series, and I wanted to v my congratulations before any more t passed.

William B. Harwood
Director, Information Serv
The Martin Company
Cocoa, Fla.

LUNAR and PLANETARY COMMUNICATION



RECEPTION
The 85 foot parabolic antenna at Goldstone, California built in 1958 and used in tracking and recording telemetry from U.S. spacecraft.

TRANSMISSION
This 85 foot antenna, seven miles from the reception facility, has recently been put in operation to transmit signals to U.S. spacecraft.

SENIOR RESEARCH SPECIALISTS

New opportunities involving advanced research and development projects are now open at JPL in the Laboratory's Telecommunications Division for engineers and scientists capable of assuming a high level of technical responsibility.

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Antenna Specialists
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Research Scientists
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Mathematicians or Communication System Analysts
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Several openings also exist for supervisors of Research and Advanced Development Projects performed by industry for JPL.

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BENDIX G-20

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The Countdown

WASHINGTON

nsorship in the Campaign?

Top Democrats are complaining that the Eisenhower dministration is "withholding" from Senator Kennedy nformation relating to national security. The clamp-lown reportedly came during a recent visit to SAC by he senator. Supposedly the word went out in conjunc-ion with Vice President Nixon's call for a "truce" on ll campaign material which would tend to indicate the J.S. is weak in Khrushchev's eyes. But there is no con-irmation of the truth of the Democratic complaint.

phon Getting Off Ground

The Navy's super-secret *Typhon* antimissile system is resently moving into the flight-testing stage. An offshoot f the *Talos* air defense missile, the long-range *Typhon* vill have integral ramjet propulsion.

ttle of the A-ICBM's

In the budget skirmishing for FY '62 a bead is being lrawn by the Air Force on the Army's *Nike-Zeus*. The eason is still money: the estimated $10 billion to $15 illion to produce the system in quantity. The heat of ttacks being made publicly indicates that the future lanning for the A-ICBM is reaching the "moment of ruth" in DOD's budget department.

und the Corner: Pershing II

Pershing II—the Army's proposed 1000-mile tactical nissile—is understood to be only a short way around he bend, if the Administration wants to move quickly. resent schedules call for deploying the first operational 50-mile *Pershing I's* in late '62. COUNTDOWN is told *ershing II's* could be in the field by about mid-1963.

das' Shot Due Soon

Look for another *Midas* IR surveillance satellite shot oon. First try last May was a partial success. Next ird will contain an R&D payload.

erational Intelligence

The Air Force discloses that the countdown for perational *Atlas* ICBM's can be advanced now to within ight minutes from lift-off—without degrading their alert atus.

INDUSTRY

other Boost-Glider

McDonnell Aircraft is working on an AF contract r the design of a boost-glide flight-test vehicle. No etails yet whether it is tied in with the *Dyna-Soar* or epresents a follow-on version.

at Office

McCormick Selph Associates and ITT have agreed on joint manufacturing and marketing venture involving a new exploding bridgewire system called XBS . . . A pact has been signed by McGraw-Edison and Standard Oil of Indiana for joint R&D of fuel cells to find an oxidizer for hydrocarbon, alcohol or hydrogen fuel . . . Boeing is ready to set up a new enterprise to capitalize commercially on research discoveries.

Big Sounding Rocket Buy

Marquardt's Cooper Development Division has won a $417,000 Army contract for 600 meteorological rockets. For an up-to-the-minute report on the expanding sounding rocket market, see page 19.

INTERNATIONAL

$11 Million Question

Britain's Peter Thorneycroft (minister for aviation) has wound up talks with Australia on the idea of forming a space research "club." The club would be composed of British Commonwealth and West European nations who would cooperate in the launching radio and TV communications satellites from Woomera. Key to the plan is whether the Aussies will agree to contribute $11 million to the scheme. Right now the Australian defense department is balking at the idea, if it has to provide the money.

British Moon Vehicle

Hawker Siddeley's Advanced Projects Group is designing moon exploratory equipment—including a vehicle for an unmanned probe and a caterpillar-tracked conveyance holding a crew of 12. The group also has a proposal for a winged, recoverable space booster.

Japan Starts Weather Rocket

Japanese Science and Technology Agency is proceeding with a three-year plan to develop a camera-equipped weather observation rocket. Camera would be installed in the warhead to take photos from 1000 kilometers. Primes for the program are the Mitsubishi Heavy Industries and Fuji Precision.

Soviet A-Plane

U.S. intelligence agencies reportedly have pictures of a Russian nuclear-powered aircraft undergoing ground tests. The craft is said to be a modified Bounder with a 200-ft. fuselage and 80-ft. wingspan.

Sunburned Eskimos?

Latest idea bouncing around Soviet scientific circles is to create a belt of potassium particles around the earth—to increase the sun's intensity upon the earth. The belt consisting of 1.75 million tons of potassium would be installed at an altitude of 1200 km between 70° and 90° north latitude.

A Modest Proposal For Survival

An Open Letter to Richard Nixon and John Kennedy

September 27

A FEW MONTHS from now a new administration will take charge of the nation's affairs. These days, these times, cry out for new and vigorous leadership.

The people of the United States desperately need to know where they stand, where they are going. More than anything they need to have objectives.

It is apparent today to virtually every thinking military and industrial leader that America as a whole does not have now, and has not had in the past four years, any grasp of what is at stake in the "exploration" of space.

There is almost no general conception of the fact that this exploration is linked technologically and strategically with the future military strength of the nation.

Our aircraft fly on the edge of space. Every ballistic missile we fire from land, sea or air will go through space. We are only a step from reconnaissance and communications via space. Only a step from spacecraft.

Yet the public has been lulled by the ambiguities of the Eisenhower Administration into believing that space really has no strategic importance. It is merely a scientific curiosity, an area to be explored for exploration's sake, with possibly some gains in television and weather forecasting.

Meanwhile, Russia forges ahead. Her military strength at least equals ours. Combined with Red China, it probably excels. Russia's initial space exploits have been greater than ours. They are providing the means for spectacular strategic exploitation of space in the years immediately ahead. This is the danger.

Redirecting our national defense and space programs will be no simple or easy task for the incoming administration. It will take courage and boldness and imagination.

We, at Missiles and Rockets, believe that such redirection must be accomplished. We sincerely feel that the national survival may well depend upon what the next administration does to ensure our world leadership in both the military and space fields.

As yet the election campaign has not produced a real debate on these most critical of issues. The American people do not realize there is such an issue.

They have no general awareness of the enormous technological changes that are taking place, no awareness of the dangers they create.

A Cosmic Curtain barring us from space would make the Iron Curtain seem like Calico.

With the thought foremost in mind that the nation needs firm objectives in defense and space, that we must have hard goals to strike for, the editors of Missiles and Rockets here propose a nine-point defense and space platform to start the next four years.

We should like to emphasize that it is only a proposal and only a start. We offer it to help fill a void which desperately needs filling. During the next four years it must be modified and amplified because it will inevitably be overtaken by technological achievements as yet unknown.

We offer it to you, Mr. Kennedy and Mr. Nixon, as a "working paper." We ask that you reply to this open letter, stating your views and making your stand quite clear on these two closely related problems.

We ask that you bring these vitally important issues into the open so that American voters may know your intentions. #

The Proposal

1. Recognize as national policy that we are in a strategic space race with Russia.

2. Expedite present space projects to provide a new and bold program with the following goals;

   Manned space platform—1965
   A U.S. citizen on the moon—1967-68
   Nuclear power for space exploration—1968-69
   A spacecraft which can take off from earth, travel to and in space, return and land under its own power—1968-69.

3. Recognize that "space for peaceful purposes" is possible only if "freedom of space" is ensured; hence that the U.S. military must be given a predominant role in developing and carrying out the projects necessary to guarantee freedom of space.

4. Establish pre-eminent strategic, tactical and defensive forces with representation from all services.

5. Recognize the necessity of greater defense funding to accomplish this, including a supplemental budget in January, 1961, to make it possible to:

   Speed up to a maximum degree the construction of ICBM launching bases, Polaris submarines and the Mach 3 missile-carrying B-70.
   Provide the Army with funds to begin the immediate procurement of already-developed modern missiles, other weapons and airlift.

6. Establish further-on defense spending by need and not by budget ceiling.

7. Streamline defense regulations and procedures to make industry's role in the U.S. defense and space effort more effective.

8. Take what steps may be necessary to establish and promote national scientific objectives.

9. Re-establish decision-making in the U.S. defense and space organizations.

A Cosmic Curtain Barring Us from Space Would Make the Iron Curtain Seem Like Calico

THE OPEN LETTER on these pages was sent to the two Presidential candidates by registered mail on Tuesday, September 27.

Their replies and/or reaction to the "Modest Proposal for Survival" will be published in succeeding issues of the magazine.

We know that you, our readers, have a great interest in what the next administration does in the space area; and an even greater stake in having these questions discussed openly and forthrightly.

MISSILES AND ROCKETS, therefore, is opening its pages to provide a badly needed forum. Contributions from you, our readers, are welcomed. We think your opinion is vital.

All submissions will be treated in confidence and anonymity will be strictly respected where requested.

All letters should be addressed to:

Countdown for Survival
Missiles and Rockets
1001 Vermont Ave., N.W.
Washington 5, D.C.

SEE EDITORIAL PAGE 50

Ike's 'Off-limits' Speech Clouds Space Policy Picture

AS THE NATION'S CAPITAL got back to work after two weeks of rapt attention to bigger affairs at the U.N., some of the aftermath of the sound and fury became clear. If there were no great victories, neither were there any great defeats.

We had not won over the new African delegations to a discernible degree, but neither had Khrushchev succeeded in abolishing the U.N. There were no major shifts in world power. A spectacular space triumph hinted at by Moscow Radio had failed to materialize, at least by M/R's press time.

One reaction to the speech made by President Eisenhower, however, seemed evident. His words implying that space was "off limits" to the military were being taken seriously in at least some quarters.

It had been taken for granted by almost everyone interested that the National Aeronautics and Space Administration would cooperate closely with the Air Force in its future *Discoverer* shots. Particularly was this thought to be true because the Air Force may quite easily place a primate in orbit before NASA does, and information gathered from such a success would be highly valuable to NASA space scientists.

However, within a few hours of the President's proposals concerning future space exploration, NASA officials not only denied that they would cooperate on the *Discoverer* shots, but denied that they had ever intended to. They also indicated that this would be the future policy.

The following is the text of the President's remarks concerning space:

Another problem confronting us involves outer space.

The emergence of this new world poses a vital issue: Will outer space be preserved for peaceful use and developed for the benefit of all mankind? Or will it become another focus for the arms race—and thus an area of dangerous and sterile competition?

The choice is urgent. It is ours to make.

The nations of the world have recently united in declaring the continent of Antarctica "off limits" to the military preparations. We could extend this principle to an even more important sphere. National vested interests have not yet been developed in space or in celestial bodies. Barriers to agreement are now lower than they will ever be again.

The opportunity may be fleeting. Before many years have passed, the point of no return may be behind us.

Let us remind ourselves that we had a chance in 1946 to ensure that atomic energy be devoted exclusively to peaceful purposes. That chance was missed when the Soviet Union turned down the comprehensive plan submitted by the United States for placing atomic energy under international control.

Proposals for Outer Space

We must not lose the chance we still have to control the future of outer space.

I propose that:

1. We agree that celestial bodies are not subject to national appropriation by any claims of sovereignty.
2. We agree that the nations of the world shall not engage in war-like activities on these bodies.
3. We agree, subject to appropriate verification, that no nation will put into orbit or station in outer space weapons of mass destruction. All launchings of space craft should be verified in advance by the United Nations.
4. We press forward with a program of international cooperation for constructive peaceful uses of outer space under the United Nations. Better weather forecasting, improved worldwide communications, and more effective exploration not only of outer space but of our own earth—these are but a few of the benefits of such cooperation.

Agreement on these proposals would enable future generations to find peaceful and scientific progress, not another fearful dimension to the arms race, as they explore the universe.

But armaments must also be controlled here on Earth, if civilization is to be assured of survival. These efforts must extend both to conventional and non-conventional armaments.

My country has made specific proposals to this end during the past year. New United States proposals were put forward on June 27, with the hope that they could serve as the basis for
negotiations to achieve general
armament. The United States
supports these proposals.

The Communist nations' walk-
at Geneva, when they learned that
were about to submit these propos
brought negotiations to an abrupt
Their unexplained action does
however, reduce the urgent need
arms control.

My country believes that nego
tions can—and should—soon be
sumed.

Our aim is to reach agreement
all the various measures that will b
general and complete disarmam
Any honest appraisal, however,
recognize that this is an immense
It will take time.

We should not have to wait
we have agreed on all the deta
measures to reach this goal before
begin to move toward disarmam
Specific and promising steps to
end were suggested in our June
proposals.

If negotiations can be resume
may be possible to deal particul
with two pressing dangers—that of
by miscalculation and that of mo
ing nuclear weapons stockpiles.

The advent of missiles, with
shorter reaction times, makes meas
to curtail the danger of war by
calculation increasingly necessary. St
must be able quickly to assure
other that they are not preparing
gressive moves—particularly in i
national crisis, when each side t
steps to improve its own defenses w
might be misinterpreted by the o
Such misinterpretation in the abs
of machinery to verify that neither
preparing to attack the other, c
lead to a war which no one had
tended.

Today the danger of war by
calculation would be reduced, in ti
of crisis, by the intervention, wher
quested by any nation seeking to p
its own peaceful intention, of an
propriate United Nations surveill
body. The question of methods ca
left to the experts.

Thus the vital issue is not a m
of technical feasibility but the poli
willingness of individual countrie
submit to inspection. The United S
has taken the lead in this field.

Today, I solemnly declare, on
half of the United States, that we
prepared to submit to any internati
inspection, provided only that i
effective and truly reciprocal. This
we will take willingly as an earnes
our determination to uphold the
amble of the United Nations Chart
"to save succeeding generations f
the scourge of war, which twice in
lifetime has brought untold sorrov
mankind . . ."

t Huntsville conference . . .

NASA Launches Studies for Moon Ship

Von Braun group to invest several million dollars for industry studies; three main approaches to moon are outlined

HUNTSVILLE, ALA.—The National eronautics and Space Administration sponsoring a series of wide-ranging udies to help determine the nature of e launch vehicle that will follow *turn* and provide for a manned land- g on the moon.

Dr. Wernher von Braun's Marshall ace Flight Center will award about contracts in the $50,000-$200,000 nge on 14 aspects of future planning the next few months. Between 10 d 20 companies will receive invita- ons to bid. The studies will cover ese areas:

–Launch vehicle size and cost alysis, study of trends in launch ve- cle guidance and control systems, de- gn study of homing systems for or- tal rendezvous.

–Studies on the C-2 *Saturn* con- uration, conceptual studies on launch hicles with thrust of 2 to 3 million s. with fully recoverage stages.

–Early nuclear flight vehicle design udy and preliminary design study for nuclear third stage in an advanced rsion of *Saturn.*

–A flight performance manual for bital operations, design criteria for bital operations and systems, design iteria and propulsion systems for or- tal launch vehicles and design criteria r lunar and planetary launch vehicles.

• **Approaching the moon**—H. H. oelle, Director of the Marshall Cen- r's future projects office, outlined the udy plans at the Center's two-day in- strial conference. There are three ap- oaches to the question of getting men the moon, Von Braun said. He listed em as:

–The brute force chemical ap- oach, using a *Nova*-type vehicle of million lbs. takeoff thrust. The major jection to this, he said, is cost. The *ova* program alone could cost more an the total present NASA budget.

–Orbital refueling and rendezvous, which seven *Saturn* launches could bit tanks of fuel to support a three- an mission to the moon and return ter a two-week stay. The objection here is the need for multiple *Saturn* launch facilities, since liquid hydrogen will not keep indefinitely and seven launches from a single complex might take up to a year.

–Nuclear upper stages, lifted by the basic 1.5-million-lb.-thrust *Saturn* booster. The objection here again is cost. The Center director estimated that a nuclear engine might cost 5 to 10 times as much as a chemical engine of similar power.

Later, Von Braun indicated he is leaning toward the nuclear solution. He told MISSILES AND ROCKETS that a 1500 megawatt reactor generating 80,000 lbs. of hydrogen thrust appears practical and it may be possible to get the reactor up to 4000 megawatts, which would give 200,000 lbs. thrust. If the higher thrust is impossible, the engines could be clustered, he remarked.

• **Launching outlook**—These other developments were reported at the conference, attended by representatives of 400 industrial, university, research and government agencies.

–Eight modified *Redstone* rockets are being produced for the early phases of the *Mercury* man-in-space program. The first two were assembled here and the other six by Chrysler Corp., with Reynolds Metals frames and Rocketdyne engines. All boosters have been delivered to Huntsville and four have been static-fired. The first *Mercury Redstone* is on the launch pad at Cape Canaveral, following a capsule-booster compatibility checkout here. The capsule at the Cape is the only one delivered so far. NASA officials say they're expecting delivery of the second capsule from McDonnell Aircraft in St. Louis "in a few days."

–Canadian-furnished topside ionospheric sounder will be one of eight satellites launched by the *Thor-Agena B* vehicle. Other items tentatively in the list are four *Nimbus* advanced weather satellites and the Polar Orbiting Geophysical Observatory *(POGO).*

–A series of five *Ranger* capsule launches, by the *Atlas-Agena B* vehicle, will begin next year. *Ranger* is a program for a rough lunar landing but the first two launches will not be aimed at the moon. They will merely test performance of components such as attitude control system, power supplies and communication equipment.

–The first ion propulsion system will probably be flight-tested in 1964, aboard a *Centaur*-launched spacecraft. Interplanetary probes may carry dual electrical propulsion-ion engines for the long pull and arc jets for short bursts of higher thrust, possibly for breaking into a planetary orbit.

–Air transport hasn't been completely ruled out for the Douglas S-IV second stage of the first *Saturn* vehicle. Oswald Lange, *Saturn* systems director, reported that he is extremely uphappy about the long time required to ship the stage by barge from the West Coast to Huntsville and thence to the Cape.

Source of Slippage Rumor

HUNTSVILLE, ALA.—*An overenthusiastic prediction by Dr. Wernher von Braun apparently was responsible for a report that the Saturn program is slipping.*

Von Braun told visitors to Huntsville at the dedication of an IBM 7090 computer last June that a new series of static tests would begin in "six to eight weeks."

Actually, according to information received by MISSILES AND ROCKETS, *Von Braun's subordinates were horrified by the statement and are hoping that everyone will forget it.*

Last week, in reply to a wire service query, NASA's Marshall Space Flight Center reported that the series actually will begin in November.

NASA spokesmen say the timing of the series is unimportant—that more data became available as a result of the last test, and the new series won't begin until the bird is completely modified into a prototype of the flight version, which still is to be flown next summer.

The Missile/Space Week

First Titan Base Activation Contract Awarded

The first subcontract for *Titan* ICBM base activation was awarded to Northrop Corp. last week by The Martin Co. The multimillion-dollar contract covers installation and checkout of missiles and ground equipment of the three-silo launch complex at Ellsworth AFB, Rapid City, S.D.

Meantime, the successful 5000-mile *Titan* shot on Sept. 28 used for the first time a refined guidance system which permits ground control of turn (or roll) in the first stage immediately after lift-off.

The data capsule ejected from the heavily instrumented dummy warhead was recovered in the target area.

A few hours later, the Army's *Pershing* suffered its first failure in seven launchings at the Cape. It was the first attempt to separate the *Pershing* and have its second stage fire. But the bird veered out of control and blew up.

Polaris Declared Still on Schedule

Polaris will still go operational this month in spite of two spectacular bloopers, Vice Adm. William R. Raborn has promised. The first missile launched from the Patrick Henry on Sept. 23 flopped ineffectually to the ocean floor without igniting; the second blew up. Although a piece of wreckage left a large dent between hatches in the deck, no casualties were suffered and damage was considered minor. Telemetry information is being studied to determine the cause of the two failures.

Decision Due on B-70 Strength

Decision as to number of prototype B-70's the Air Force will buy is "imminent," a DOD spokesman says, although production dates will not be set until the program is farther along. DOD officials implied that development would start in ample time to avoid further delays in the strategic bomber program—now scheduled to become operational in late 1965.

The AF is also looking into best methods of beefing up the development program; a decision as to the most feasible is expected shortly. There may be a substantial fund increase in both 1961 and 1962.

Aerospace Recruiting Gains Momentum

Personnel recruitment will be stepped up next month at Aerospace Corp., the Air Force's new in-house company replacing Space Technology Labs. President Ivan A. Getting said the key executive spots are now filled and a rapid buildup of technical teams is under way. Biggest problem has been how to get as much technical know-how as possible from STL without crippling it. Latest shiftover—Jack H. Irving, new Aerospace VP-general manager, systems research and planning. Irving formerly was deputy to STL's Allan Donavan, who now is Aerospace vice president and technical director. Getting also reveiled that the laboratories division, headed by Dr. Chalmers W. Sherwin, will play a bigger role in Aerospace than it did at STL.

European Space Program Awaits Ratification

The proposed European space research program may get going shortly insiders say, if six or more nations give it the nod. The embryonic European Commission for Space Research—spearheaded by an energetic U. of Paris professor—is meeting this week in London to complete its formal organization. Nations invited to join: Belgium, Britain, Australia, Denmark, Italy, The Netherlands, Norway, Sweden, Switzerland, West Germany, and France. Professor Pierre Victor Auger is executive secretary and chief protagonist. Some of the assets in the group: France's highly successful *Véronique*, and the possible resurrection of the impoverished British *Blue Streak/Black Knight* space program. Australia's participation would bring in the Woomera rocket range, to supplement the French range at Colomb Béchar.

Soviet Scientist Hints Man In Space Shot to Come Soo

A Russian will be in outer spac
before very long, according to Vladim
Timakov, vice president of the Sovi
medical academy.

Timakov, in an interview with Tas
said "there are no more problems co
nected with (manned) space flights th
cannot be solved by contempora
science."

The Soviet scientist revealed co
siderable information on the Red astr
nauts. He said they are all jet pilo
and of slight build, since "every gra
of weight counts in space."

Their daily training schedule,
said, takes into account every minu
and requires approximately one mont
Training includes the study of astro
omy, botany, medicine, electronics ar
geography, as well as specially select
sports.

"Special pills have been developed
he said, "for correcting any nervo
system irregularities in case of a
departure from normal in the astr
naut's organism while in flight." A
cording to Timakov, however, the astr
naut will not actually pilot the spa
vehicle since "for safety reasons" spa
flights will be controlled from earth.

Conjecture that the Russians m
have already tried unsuccessfully
launch a man into space was strengt
ened somewhat by reports from Switz
land that a radio ham may have
corded the voice of a Soviet rock
pilot. A 37-year old radio technic
reportedly made a 25-second tape
cording on January 17 of transmissio
on the Russian satellite transmitti
frequency. Due to the frequency us
and reception characteristics indicati
transmission from a "very fast-movin
object, he concluded that the voi
may have come from a rocket pilot.

The recorded voice reportedly
peated the Russian equivalent of on
two-three (ras-dva-tree) several tim
then faded away as it was apparent
pronouncing other words.

Plasma-Coated Nozzles Take 5500°F Beating

Plasma application of metal co
ings to experimental nozzles sh
promising high-temperature charact
istics at Rocketdyne's Solid Propuls
Operations, McGregor, Tex.

The plasma-sprayed metal powde
have been instrumental in protecti
nozzles from exhausts exceedi
5500°F. Alumina, tungsten and tungst
carbide bond to the nozzles in app
cation temperatures over 25,000°

Pre-election Moon Shot Still Possible

Latest probe effort fails with surprise fizzle of Able; backup available for another launch late this month

THE LAWS OF astronomy give the enhower Administration one more ance to achieve an earth-moon jectory before election.

A backup *Atlas-Able* vehicle and yload are on hand at Cape Canaveral d an attempt presumably will be de when the moon next comes near rigee, in the period Oct. 22-26.

The seventh in America's dismal ies of moon-probe attempts failed pt. 25 when the *Able* second stage led to reach full chamber pressure d burned for only about 80 of the eduled 110 seconds.

It was a case of the law of averages ching up with the hitherto reliable uglas-Aerojet-General *Able*. Aerojet d *Able* had a perfect 15-15 record il then.

The cause of the engine failure was der investigation. It could have been the engine itself, in separation or in structure holding the nozzle in ce.

The *Atlas-Able* vehicle, for which cials of the National Aeronautics d Space Administration never were husiastic, now has been plagued by ee straight failures and, unless the t one succeeds, may become obso- without ever achieving a successful nch.

NASA originally planned to fire y one *Atlas-Able*. The *Atlas* blew on the launch pad in a pre-flight in September, 1959—the same nth the Soviets fired two successful on shots.

In response to widespread public nand, NASA diverted an *Atlas* from Project *Mercury* test program for in a second *Atlas-Able*. That one, nched Nov. 26, 1959, failed when fairing fell off the nose just as the ond stage ignited.

• **No reflection on Altair**—Ap- ently no more *Atlases* were available moon shots until this spring. At that e, Dr. Abe Silverstein, director of NASA Office of Space Flight Pro- ms, told the House Appropriations committee that the program had n delayed for a new environmental of the payload package because of vibration level of the third-stage ket. Silverstein told M/R there was reflection on the third-stage *Altair*, manufactured by Allegany Ballistics Laboratory, a Navy-Hercules Powder Co. installation. *Altair* has had more than 15 straight successes and apparently fired again last week.

The 387-lb., 39-in.-diameter payload was to have been put into a 5000-mile orbit about the moon—one of the few space spectaculars presumably within U.S. capability that Russia has not already accomplished. A twin-chamber hydrazine engine was carried to provide reverse propulsion. Each chamber was able to deliver 20 lbs. thrust. Fuel was carried to run the engines 1700 seconds.

The reverse thrust, designed to slow the craft as it neared the moon, operated by valving hydrazine across an aluminum oxide catalyst bed. Pressure is maintained by small nitrogen tanks.

Power is supplied by 22 solar-cell modules producing 1.3 watts under direct sunlight. The craft carried these experiments:

–A 1-lb. micrometeorite detector, consisting of a diaphragm and a microphone, to transmit to earth the sound of particle impacts.

–A 5-lb. package of six argon-filled cylinders ranged around a seventh cylinder wrapped in a thin lead shielding, which by ionization was to detect electrons in the energy range of 12 to 70 million volts (Mev).

–A 2-lb. box containing an ionization chamber and a Geiger-Mueller tube for measurement of total radiation—particularly in the medium-energy range.

–A 2-lb. scintillation counter for monitoring low-energy radiation.

–A 2½-lb. flux-gate magnetometer, similar to the instrument on *Pioneer V* that detected a measurable earth magnetic field out to 65,000 miles.

–A 4-oz. photoelectric cell to report when it is pointed at the sun—for use as a reference for the magnetometer.

–A 1½-lb. plasma probe experiment, consisting of an electrometer measuring the energy of protons passing through a slit, to measure intensity of the solar wind as affected by the elecstatic forces and magnetic field in the earth's neighborhood, and strong solar flares.

–Two packages weighing a total of 3½ lbs. to measure the energy spectrum of interplanetary protons and to measure any radiation trapped around the moon.

Tracking duties were assigned to Jodrell Bank, England; Millstone Hill, Mass.; South Pt., Hawaii; Goldstone, Calif.; Cape Canaveral and a small receiver operated by Space Technology Laboratories at Singapore. ⌘

U.S. Moon Probe Attempts

Vehicle	Launch Date	Results
Pioneer I (Thor-Able)	Oct. 11, 1958	Traveled 70,000 miles
Pioneer II (Thor-Able)	Nov. 8, 1958	Third stage failed to ignite
Pioneer III (Juno II)	Dec. 6, 1958	Traveled 63,000 miles
Pioneer IV	March 3, 1959	Achieved escape velocity, passed within 37,300 miles of moon and entered solar orbit
Atlas-Able I	Never launched	Vehicle blew up on pad September, 1959
Atlas-Able II	Nov. 26, 1959	Fairing fell off nose just as second stage ignited
Atlas-Able III	Sept. 25, 1960	Second-stage failure

At ASA Convention

Air Force Brass Assails Army Zeus

San Francisco—Army's *Nike-Zeus* switched roles here last week at the Air Force Association Convention. It was the target of a large number of potshots aimed by high AF brass.

They all agreed that an anti-ICBM was the "most critical current need for the nation's defense." But few thought *Zeus* was the answer, in spite of the fact that this is the only U.S. antimissile system even close to production.

Lt. Gen. Roscoe C. Wilson, AF deputy chief of staff, dismissed the *Zeus* as an exceedingly imperfect solution, "prohibitively expensive," and "probably not the best approach to the problem." He said that trying to destroy a missile in the mid-flight phase of its trajectory offers the least prospects for a solution; he pointed out that the AF is concentrating its research on a launch-phase kill.

AFA directors, in drafting the Association's statement of policy, minimized the Army's *Zeus* effort and plumped for more vigorous antimissile research—deploring the "singular lack of imagination, determination and tenacity" in this area.

On the other side, Gen. Laurence S. Kuter, Chief of NORAD, said that his organization favors pushing *Zeus* as the best answer currently available. He urged an immediate start of production.

Still a third view was expressed by Dr. Edward Teller, of the University of California, who called the AICBM concept impossible and advocated surveillance and intelligence satellites as the best U.S. hope for preventing military domination of space by an enemy. "Such vehicles would be better protection than any anti-ICBM device we're likely to conceive now or in the future," the H-bomb physicist said.

• **First do the research**—There was a noticeable lack of speculative or wildly imaginative predictions on military uses of the space environment at this year's panorama here. Instead, there was the soft sell: learn more first through research about the space environment before going ahead with operational systems.

George Sutton, former ARPA chief scientist now with North American Aviation, Inc., took the stand that it
is difficult to see how we can use spa
for either offensive or defensive mea
until there is much more research.

Sutton sees a gradual, but n
radical, increase in funds for spa
projects. He said that future projec
will be selected much more careful
to give a longer lifetime before obs
lescence. Next year, he added, the
will be little money available for sta
ing new projects.

James H. Doolittle, chairman of t
board of Space Technology Labor
tories, predicted that in the next deca
our principal deterrents, both offensi
and defensive, will be in space. F
said space will have a role in the ta
tical mission and that main defensi
systems would be in reconnaissanc
navigation, communications ar
meteorology.

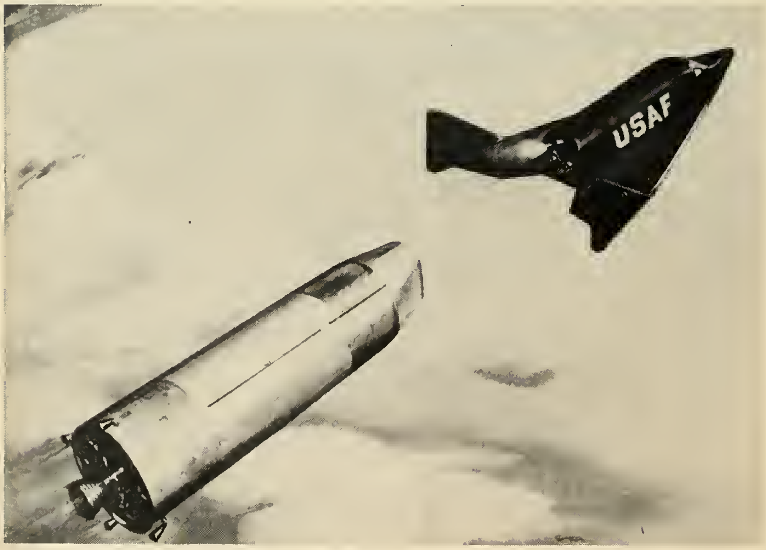
• **Planning and economizing**—B
ter planning and management we
called for to utilize our technologic
advancements. "The pacing factor
our progress today is not technolo
but management," said Lt. Ge
Bernard A. Schriever. "Unless it
properly applied, we will lose the w
of survival."

Maj. Gen. Kenneth P. Bergqui
commander, AF CCDD, pointed o
that revolutionary advances in the d
structive power of weapons and in t
speed and range of delivery syster
have created a "crisis in commanc
He said there is a real danger th
command and control systems will "f
between two stools," being neither r
liable enough to permit us to laun
a quick strike before being hit by
surprise attack nor survivable enou
to control our reaction after being h

From a program sense, Bergqu
said, more attention must be paid
planning in the early conceptual phas
of these systems to insure that the ne
is sound, the systems are achievab
from the state-of-the-art viewpoint, a
that sufficient analysis is conducted
insure that the system is within reaso
able or anticipated resources.

The need for economy was stress
by several speakers. According to l
Gen. W. F. McKee, vice-command
AMC, industry can expect intensifi
efforts to reduce costs and must l
prepared to readjust accordingly.

Maj. Gen. O. J. Ritland, BM
Commander, said efforts are alrea
being made to cut the cost of putti
payloads in orbit.



How Dyna-Soar Will Look

THE AIR FORCE says that the manned version of Dyna-Soar "does not require acceleration" at this time and isn't being considered primarily as a competition with Russia to get a man into space. The configuration shown above was released by the Air Force at the AFA and is similar to the Dyna-Soar design first revealed in M/R (June 13, p. 18, and Aug. 15, p. 13). Experimental flights of the space glider are planned within three years, using a specially designed finned Titan as booster. (See cover.)

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SOUNDING ROCKETS

SPECIAL REPORT

- The field is giving the propulsion industry an expanding multimillion-dollar market
- Australia, Canada, France and Japan are leaders abroad; Buenos Aires symposium may add impetus
- Directory of U.S. sounding rockets: the first unclassified compilation to be published
- Dr. S. Fred Singer reports on European programs and plans to buy U.S. rockets and instruments

SOUNDING ROCKETS
SPECIAL REPORT

Market

by Jay Holmes

SOUNDING ROCKETS—an are often overshadowed by the more newsworthy satellites and long-range missiles—provide a steady and growin market for the U.S. propulsion industry. A big new demand is developin abroad.

Government agencies are spendin about $6 million this year on smal rockets used for weather sounding, investigation of the upper atmospher and near-space, target missiles and development testing of satellite system Another $15 to $30 million will b spent on launch vehicles for the NAS *Scout* and the Air Force *Blue Scou* programs, designed for longer probe and orbiting small satellites.

Dozens of sounding-rocket vehicl are under development and test by th military services and the National Aer nautics and Space Administration. Bu nowhere in the government is there central repository of information o sounding-rocket performance, reliabi ity, costs and other factors.

To fill this gap, NASA's Langl Research Center last week receive bids from industry on a 3½-mont study of the data for 16 existing soun ing-rocket systems and individual pe formance, reliability and cost repor on 20 rocket motors. NASA spokesm said, however, that the study will n necessarily be limited to the moto and vehicles listed. The results will l made public as a NASA technic report.

A NASA official was asked wh such a job would be performed by a industry contractor, who might find difficult to be completely imparti about the value of a system if it h

SIX-STAGE research rocket is readied f firing at Wallops Island. Visible stages Honest John, Nike and Lance.

rowing at Home and Overseas

.S. programs this year will invest $21 to $36 million in area roviding profitable production work; weathermen seek bigger firing schedule

xperience or an interest in selling a ystem. The official, who preferred not o be quoted by name, said the work ill be closely monitored and any im- artiality would be recognized easily.

• **First unclassified list**—Pending the ASA study, MISSILES AND ROCKETS resents the first unclassified compila- on of sounding rockets as part of this pecial report. Performance figures are s given by manufacturers. Rocket per- ormance is based on unclassified gov- rnment reports. (See p. 26)

The proliferation of new rockets nd multi-stage systems results from e steady trend from solids to liquids. he *Aerobee*, a liquid system, was the nly research rocket flying a few years go. Now, dozens of solids have ached the point where they are com- etitive.

Aerobee-Hi is still in heavy use be- use its long use has made it ex- emely reliable. And, as a low-acceler- ion liquid system, it will not beat up sensitive payload. But *Aerobees* are pensive; both NASA and the military ill be interested if solids can be de- loped to do the job cheaper and more liably.

• **Profit advantage**—Reliability is a quirement stressed repeatedly by unding-rocket users. To get it the rchaser is often willing to sacrifice rformance; the most popular rockets e obsolescent.

For the manufacturer, small sound- g rockets provide one of the few eas in the missile/space business here he can go into production— ten a more profitable endeavor than pensive research and development ograms.

Firing of small rockets is expected increase both in this country and road. The Committee on Space Re- arch (COSPAR) of the International ouncil of Scientific Unions is sponsor- g worldwide programs that will increase in frequency in the coming years.

Last month, from Sept. 16 to 22, research rockets were launched around the world in an International Rocket Interval observed for the second year as an outgrowth of the International Geophysical Year. Two such intervals will be observed next year. The greatest number of firings in September were for meteorological investigations in the altitudes from 15 to 40 miles.

• **Need will expand**—In this country, meanwhile, cautious moves are under way toward establishment of an operational meteorological network. Beginning Oct. 17, seven or eight rocket ranges will fire one meteorological rocket daily on weekdays for an entire month. The "rocket month" will occur once each season, building up to a time when 10 ranges will be taking part.

Meteorologists in the U.S. Weather Bureau and the military weather services want to bring the firing rate up to one shot a day from points on a grid 500 to 1000 miles apart across North America. To forecast weather accurately for jet aircraft operating at 60,000 ft., weathermen need detailed information on winds up to 200,000 ft.

Until now, the Army has been procuring most of the rockets and supplying many of them to agencies operating the other ranges. In Fiscal Year 1960, the Army bought 500 rockets. A spokesman for the Army at White Sands, N.M., said it is expected that procurement this year will be at about the same rate. If the firing rate is increased, other agencies will have to pitch in and buy some rockets.

Circulating in the Weather Bureau is a proposal to procure a relatively large supply of sounding rockets in FY '62.

• **Early models**—Up to now, about four-fifths of the rockets used for altitudes up to 200,000 ft. have been the Atlantic Research Corp. *Arcas*. The remainder were an uprated version of the *Loki*, an old Army antiaircraft missile.

However, neither the *Arcas* nor the *Loki* is completely satisfactory for an operational sounding-rocket system, Weather Bureau sources say. *Arcas*, an end-burning polyvinyl chloride motor, generates a thrust of 350 lbs. and burns 28 seconds, with a maximum acceleration of about 30g.

The low acceleration of *Arcas* treats the payload gently, contributing to reliability, and uses much of the thrust at high altitude, where the rocket is more efficient. But if there are winds aloft, they can cause a high degree of dispersion on the way up. This is not a serious problem on a national rocket range. But it creates difficulty in the neighborhood of a populated area.

Loki, on the other hand, burns at 2000 lbs. thrust for 1.9 second, giving maximum acceleration of 200g. The bullet-like ascent overcomes some of the dispersion problem, but the acceleration gives terrible punishment to the payload.

One Weather Bureau official calculated that the *Arcas* case will fall in an area 20 by 40 miles, while the *Loki* case can be counted on to fall in an area 10 by 25 miles. In both cases, the payload is returned by parachute.

An even narrower dispersion—5 by 20 miles—results if the *Loki* is fired from a 5-in. gun as in the Navy's High Altitude Sounding Projectile (HASP), just developed by the Naval Ordnance Laboratory, Silver Spring, Md. So far, however, NOL is using an older model of the *Loki*, which reaches only 20 miles altitude with the weather sonde, consisting of a temperature-measuring thermistor and a radio transmitter powered by a 6-volt battery.

• **Newcomer**—Another entry in the contest is provided by Rocketdyne's new *Aeolus* weather-sounding rocket,

ALTAIR fourth stage of NASA's Scout is given last-minute checks at Wallops before being raised to its final position atop the first three stages of the space exploration vehicle.

under development in a company-sponsored program. Rocketdyne reports that *Aeolus* is designed to reach just as high as *Arcas* with a rocket midway in performance between *Arcas* and *Loki*. *Aeolus*' motor burns at 660 lbs. thrust for 12.7 seconds, holding acceleration to a maximum under 30g for a 6-lb. payload.

Aeolus may not fare well in competition with *Arcas* and *Loki* immediately because an established rocket, with a long reliability record, will be preferred. However, if performance meets the claims based on design, it may eventually move into the picture.

For use very close to cities, at least two companies are studying the possibility of a consumable rocket. One obvious possibility would be a rocket with case and nozzle of heavy, paper-like material, which would burn up on the way down. Another is a paper rocket operating on the nozzleless principle. Neither of the companies involved is willing to go into details, on the ground that it is too early.

• **Next Class**—After the weather-sounding rockets, the next class of importance is those capable of lifting payloads into the ionosphere, which begins at about 70 miles altitude. For many years, that job was handled by the old *Aerobee*, a liquid rocket burning nitric acid and alcohol. For altitudes above 150 miles, Aerojet-General added a solid booster.

Recently, Aerojet has developed the *Aerobee Jr.* (*Aerobee 100*), which uses the solid booster and a scaled-down *Aerobee* motor. This utilizes the comparative economy of the solid booster to reduce the size—and thus cost—of the liquid engine, which burns IRFNA and JP-4 in the latest version. NASA has flown one *Aerobee Jr.* and has six on order. Aerojet says they cost about $20,000 apiece.

In an effort to produce an all-solid rocket that will compete with *Aerobee Jr.*, the Naval Research Laboratory—and later NASA—sponsored development of the *Arcon* by Atlantic Research Corp. However, NASA officials report, *Arcon* did not reach the altitude desired and was not procured.

Last spring, NASA gave Atlantic Research a $100,000 contract to convert *Arcon* to aluminized propellant and make some other changes to bring it up to the present state of technology. If the program is successful, the new *Arcon*—which the company calls *Archer*—may prove a serious competitor for *Aerobee Jr.*

Next along the line is a two-stage vehicle, *Nike-Cajun*, which is in wide use to lift payloads of about 50 lbs. to about 100 miles. The booster, taken from the *Nike-Ajax*, develops 50,000 lbs. thrust for 3 seconds. *Cajun*, a Thiokol rocket used in the *Pogo-Hi* target missile, gives 8100 lbs. thrust for 2.8 seconds.

For yet higher altitude, *Nike* is used with the *Asp*, a Cooper Development rocket to lift 50 lbs. to 150 miles. Some competition for *Nike-Asp* may come from *Nike-Apache*, using a new Thiokol upper stage that probably won't reach quite as high, but which Thiokol says will be more reliable.

• **Higher level**—Another layer of the ionosphere begins at about 187 miles up. A standard vehicle capable of going this far is the *Aerobee-Hi* (*Aerobee 150*). But it costs about $30,000 Everyone in the business is interested in a vehicle that will do the job cheaper

The solid-liquid *Aerobee-Hi* holds a large volume payload and treats i gently with an acceleration that stays under 13g. A possible competitor under development is the *Iris*, an end-burning Atlantic Research solid. *Iris*, begun by NRL and continued by NASA, lifted 150 lbs. of test gear to 140 miles in it first test last summer.

Next on the ascending order is the *Exos*, a three-stage solid vehicle developed for the Air Force by the University of Michigan. The *Exos*, a combination of the *Honest John* Army missile motor, a *Nike* and a Thiokol *Recruit*, has lifted 80 lbs. to 300 miles A later version of *Exos* uses as third stage the *Yardbird*, a Thiokol rocke that burns slower, reducing the g loa on the payload, and lifts it a littl higher. Since NASA now has no three stage rocket in this performance range it is possible that it may adopt *Exos*.

Continuing up the scale is the *Arg E5*, a five-stage vehicle produced b Aerolab Development Co. for Projec *Jason*, the measurement phase of th Project *Argus* nuclear explosions i space. The *E5* lifted payloads to th 400-500 mile range.

Since then, NASA has switche over to *Argo D4*, which the Air Forc called *Javelin*, for that class of exper ment. The *D4*, also produced by Aerolab, gets up to 7-800 miles and has th simplicity advantage of having on four stages.

On the highest suborbital leve NASA is using the *Argo D8*, sometim called *Journeyman*. In its first test Sep 19, *Argo D8* lifted the 83-lb. NER (nuclear emulsion recovery vehicl payload 1200 miles up and 1200 mil down the Pacific Missile Range.

This year, NASA is concentrati on *Aerobee*, *Nike-Cajun*, *Nike-As* *Argo D4* and *Argo D8* for its subo bital missions. The Air Force is usi *Aerobee*, *Nike-Cajun* and *Exos*.

NASA will procure a few Briti *Skylark* rockets for missions in t Southern Hemisphere. It decided to f *Skylarks* from the Australian range Woomera rather than go to the exper of delivering U.S. rockets and esta lishing special launch facilities.

For the longest and highest su orbital missions, *Scout* and *Blue Sco* will be used—creating a fuzzy bord line between sounding rockets a satellite launch vehicles.

SOUNDING
ROCKETS
SPECIAL REPORT

Europe's Ambitious Plans to Explore

Extreme interest in small sounding rockets for upper-atmosphere research opens big market for U.S. makers

by S. Fred Singer

EUROPEAN COUNTRIES entering ne rocket and space research field have wo great advantages over the United tates, both arising from the fact that hey are largely indifferent to prestige onsiderations: They can afford to deelop their best vehicles for scientific urposes, and they can spend time in eeking an economical approach to their pace research interests.

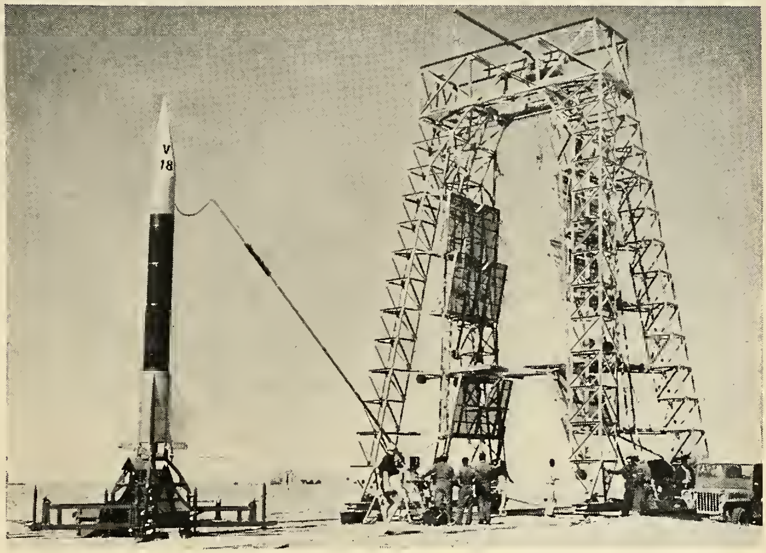
On the other hand, of course, many f the exciting problems are being atacked in the United States and the oviet Union with advanced sounding ockets and satellites. For this reason, he European scientists interested in pper-atmosphere exploration and other pace experiments are spending much me and serious thinking on the design f the experiments and on the best aproach to them.

This philosophy was keynoted by ritain's Prof. H. S. W. Massey in his peech during the inaugural program of he August meeting of the International stronautical Federation in Stockholm. Ie suggested, in fact, a network of ounding rocket stations to probe the nportant problems of the ionosphere —and even the lower atmosphere from 0 to 50 miles, which is now beyond he reach of balloon-borne equipment.

With this in mind, it is interesting o see how various European countries re proceeding, each in its own way, to et up a sounding rocket program.

The Italians, for example, have tarted rocket tests on the island of ardinia and are planning, later this ear, to launch two *Nike-Asp* rockets ith various geophysical experiments. rofessor L. Broglio, of the University f Rome, has been mainly concerned ith problems of aerodynamics and rentry physics, while Professor G. Rigini, of the Astrophysical Observatory n Florence, has described the interestng results which can be obtained with ounding rockets during solar eclipses.

One of the projected experiments nvolves the release of sodium vapor s a means of determining winds in the ionosphere, The luminosity will be tracked by optical ground stations located on the Italian mainland and on Sardinia.



UMBILICAL CONNECTION is set prior to a recent launching of the French Véronique rocket at Colomb-Béchar in the Sahara Desert.

- **Auroral exploration**—One of the most important locations for upper-atmosphere research is the auroral zone. At the present time, the only well established launching station for rockets is located in Fort Churchill on Hudson Bay. At this Canadian station many of the important IGY experiments were conducted.

The Canadian National Research Council is now carrying on a program which is based on a Canadian-built sounding rocket, the *Black Bart*. This rather large, single-stage solid-propellant rocket will be used first to measure the incidence of cosmic rays produced after solar flares, and to study auroral particles. Launchings are expected in the very near future.

Sweden and Norway also are considering launching stations in the auroral zone and hope to make similar experiments, but with greater emphasis on studying the properties of the ionosphere itself and evaluating propagation conditions in the polar zone.

- **U.S. rockets being chosen**—Both Sweden and Norway have pretty well decided to use American-built rockets, and plan to buy them directly from various suppliers in the United States. They have scientists who could construct small sounding rockets in their own defense laboratories, but they cannot spare the manpower from their more urgent defense problems and therefor prefer to buy available equipment.

Among the rockets which they are going to favor are the medium-sized *Nike-Cajun* and *Nike-Asp*, and the smaller *Arcas*, *Asp*, and *Phoenix* rockets. No final decision has as yet been made; the Scandinavians are studying very carefully the experience of various American experimental groups before making firm plans.

The projected Swedish launching station is located exactly on the Artic circle near the little town of Jokkmokk.

The range there has been in use as an artillery and military rocket range. The region is deserted enough so that no serious problems exist for sounding rockets which go to altitudes of 100 miles.

The Sweden Space Committee consists of a group of well-known physical scientists under the chairmanship of Professor Lamek Hulthen of Stockholm. The Secretary of the committee is Dr. E. A. Brunberg.

The Norwegians are considering a launching station on the west coast in the vicinity of the Auroral Observatory of Tromsö. Firing out over the North sea, they will be able to deal with rockets of any altitude without any serious safety problems.

The Norwegian approach is very much keyed to a small rocket with a small, near-portable launcher. The group concerned with these launchings is from the Norwegian Defense Research Establishment at Kjeller; it is primarily interested in the physics of the lower ionosphere. Its space committee consists of a distinguished group of scientists under the leadership of Dr. Odd Dahl and Professor Sven Rosseland. The secretary is Dr. B. Landmark.

• **Down-to-earth space talk**—Many of the European plans and problems were aired at the Stockholm Symposium.

The first session dealt with available small sounding rockets; in this session, various American speakers discussed the *Nike-Cajun*, *Arcas*, *Asp*, *Phoenix*, *Terrapin* and other proven vehicles. The British described their solid-propellant *Skylark*, and the Japanese gave a very detailed account of all of the work done in connection with the *Kappa* rocket.

The second session of the Symposium was devoted to a very practical discussion of questions of launching, range problems, instrumentation problems, both on the ground and in the rocket. This took the form of an informal panel in which the chairman debated certain technical questions with members of the audience who had experience, for example, in telemetering or in the design of launchers.

The third session was devoted to scientific plans. Here a number of scientists discussed the disciplines and problems in which small rockets could make an important contribution.

• **Variety of possible experiments**—Dr. M. Nicolet of Belgium described some of the unsolved problems of upper-atmosphere chemistry. He indicated, for example, how rockets carrying various reactive gases or metal vapors could be used to trace the photo-chemical processes which go on in the ionosphere. A great variety of such experiments could be attempted.

LONG TOM rocket, highly sophisticated sounding vehicle, shown at Woomera.

In some cases even small quantities of reactive gases could affect the properties of the atmosphere in an important way. Frequently, luminosities would be produced, which could be observed and tracked from the ground during the night. In other cases, the ionization in the upper atmosphere would be affected. It became clear that 20 to 50, or even 100 rocket experiments per year could well be carried out in this program alone.

Far more important in terms of numbers are meteorological measurements with small rockets. These were described by Dr. Bolin of Sweden, who pointed out some of the investigations which could be conducted at altitudes above 100,00 feet, inaccessible to meteorological balloons.

For meteorological purposes particularly, it is necessary to make synoptic observations at many points on the earth's surface. Dr. Bolin looked forward to several hundred or more rocket firings a year before some of the problems concerned—particularly those involving polar meteorology—could be cleared up.

• **Mysterious clouds**—An interesting subject touched on by Dr. Witt of Sweden was described the phenomenon of "noctilucent clouds," which exist at altitudes of some 50 miles. The origin of these clouds is not as yet settled. They are seen in the sub-Artic region, but rather infrequently. One school of thought holds that they are little ice crystals; others think that they may be dust particles. One way of investigating their origin would be to release dust particles from a rocket to see whether such clouds can be formed artificially.

Prof. Alfven of Stockholm described some of the important problems of the aurora which could be attacked by means of small sounding rockets. He stressed particularly the use of magnetometers—for example, some of the newer proton precession and electron precession magnetometers which developed recently in the United States. The magnetometer readings can trace out the distribution of electric currents in the aurora. Some of these currents have strengths of several hundred thousand amperes and important effects on the earth's magnetic field.

A vital topic is communication in the polar regions. Radio communication is often affected by solar outbursts of high-energy particles, so called solar cosmic rays. The earth's magnetic field focuses them into the polar zones; there they can produce sufficient ionization at low enough levels, between 50 to 80 km, to cause a radio blackout.

Dr. Hultqvist of the Geophysica Observatory of Kiruna in northern Sweden described how his group i planning to study the mechanism o polar-cap absorption and radio blackout in more detail by means of high altitude sounding rockets.

Finally, Prof. Tengstrom of Up sala, Sweden talked about the use o rockets for geodetic purposes. Sma light sources carried aloft could b used to triangulate over large distances He showed how a chain of some doze rocket launching stations across th earth could be used for more accurat map making and studies of the shape o the globe.

• **Big export potential** — Wha emerged from the Stockholm Sympo sium was, first of all, the extreme in terest with which European scientis now regard the use of small soundin rockets as a tool for upper-atmospher research and as a means for getting in to space work.

Funds are becoming available t them in increasing larger amounts d rectly from their respective goverı ments. For example, the Swedes hop to be supported directly by the Swedis parliament, rather than through th existing National Research Counci An important export market appea to be opening up for American-mac rockets and instrumentations.

Four Nations Lead Foreign Progress

by Bernard Poirier

THE FOUR outstanding sounding cket programs outside the United tates and Russia—judged in terms of rogress—have taken place in Aus-alia, Canada, France and Japan.

The longest continuing effort has een accomplished by France, whose ounding rocket development started in 939 and continued throughout World Var II. A French research rocket de-eloped during the war has design lines mmon to most sounding rockets used d developed since then.

Countries showing promise for the ming year include India, Italy, rgentina and Sweden. Of these, only aly appears to have satisfactory gov-nment backing. Argentine rocketry partially state-supported. Space re-arch may get more recognition, how-ver, if the November rocket sympo-um in Buenos Aires is as successful anticipated.

Future military implications are ob-ous with the revelation of the French *ntares* rocket tests. Designed by the ffice National d'Etudes et de Récher-hes Aeronautiques (ONERA) this ur-solid-stage rocket evolved from the NERA 56/39-22D, which had two uid stages and two solid stages.

• **First act for France's IRBM**—he *Antares* first and third stages are ade by SEPR. The new second stage as conceived by the Ruelle Naval rsenal's Service d'Etudes et de Fab-cations d' Engins Spéciaux. The last ge—solid-fueled and instrumented—s developed by ONERA. Rocket fuel produced by France's Service des udres.

The May test of the *Antares* was nducted by the French Navy and NERA on Levant Island primarily r the benefit of Sud-Aviation (one the prime IRBM development con-actors of France's S.E.R.E.B. or-nization), whose IRBM is symbol-ed as the *SS.BS.1.*

First-stage thrust was 44,080 lbs. r 5 secs; second-stage 4408 lbs. for secs., and third-stage 7714 lbs. for 6 secs. The fourth stage was fired the downward trek at an altitude 27.95 miles. It was during this period the 6¼-min. flight that the nose ne attained maximum re-entry velocity of 7286 ft./sec. at 15.5 miles altitude.

• **Classical vehicle design** — The *Véronique* is one of France's top meteorological vehicles for tests above 120 miles altitude. Designed by DEFA's Laboratoire de Récherches Balistiques et Aerodynamiques at Vernon, the liquid rocket develops 9000 lbs. thrust for 45 sec.

The *Véronique* is about 23 ft. long and is fueled by nitric acid and terebenthine. The fuel accounts for 2204 lbs. of the total 3286-lb. take-off weight. Its design closely parallels the French rocket developed during World War II.

A missile of similar appearance can be seen blasting off from Fort Churchill in northern Canada or from Woomera in southern Australia.

The two-year research in the Canadian *Black Brant* rocket was known by the code name *Snow Goose.* The design is by the Canadian Armament Research and Development Establishment at Valcartier, P.Q. The solid-fuel research and configuration evaluation was done by the Guided Weapons Division of Canadair, Ltd. of Montreal.

• **Second Hudson Bay era**—Bristol Aircraft Ltd. of Winnipeg manufactures the rocket's cylindrical casings.

The single-stage *Black Brant* has been successfully fired 125 miles northward into Hudson Bay from Fort Churchill launching sites. It develops 20,000 lbs. thrust for 20 secs. in reaching Mach 5 and a trajectory apogee of 60 miles.

• **Efforts Down-Under** — Britain's best offerings in missiles have been evaluated at Australia's Woomera test ranges. The Australian Weapons Research Establishment has tested the *Blue Steel, Bloodhound,* and *Blue Streak,* to name just a few.

The *Skylark* research vehicle has often shattered the stillness of the Koolymilka launch area 25 miles from the town of Woomera.

The *Skylark* was developed by the Royal Aircraft Establishment. The nozzles and cases are fabricated by Bristol Aerojet Ltd.; the case is made of 1% chrome molybdenum steel as spec. RS. 120, and the nozzle is formed of an asbestos-filled phenolic-resin composition.

Its fuel is ammonium picrate, ammonium perchlorate and polyisobutylene. The vehicle uses 5 lb.-thrust stabilizing air jets.

The 18-ft.-long *Raven* solid-fuel engine powers the single sustaining stage. A new booster called *"Cuckoo,"* developing 81,000 lbs./sec. for 4 secs., has been added to supplement the *Raven* and improve performance.

• **Woomera like Colomb-Béchar**—Several rockets of Australian design and construction include the sophisticated *Long Tom,* which has been mated as a subsequent stage to the *Blue Streak* in recent tests, and the versatile and less expensive *Aeolus* research rocket.

Both the *Long Tom* and the *Aeolus* are fabricated by the Weapons Research Establishment at Salisbury and have been tested at Woomera's ranges. Both Range A and Range E at Woomera are semi-arid and relatively uninhabited wastelands similar to France's Colomb-Béchar range in Algeria.

The two-stage *Aeolus* is initially powered by seven boosters in a cluster which cut off at .6 mi. while the vehicle coasts to over three miles after the first-stage boosters fall away.

• **Hulme reveals rocket data**—The second stage is fired to its burnout point near five miles at Mach 4.5. Top altitude has been given by Alan S. Hulme, Australia's acting Minister for Supply, as "between 150,000 and 250,000 ft. with payloads similar to the *Long Tom*".

The *Long Tom* is reputed to carry payloads of 100 to 150 lbs.

The 630-lb. first stage of the *Aeolus* has seven 5-in. motors fitted to a common cast aluminum-alloy thrust plate. The second stage's full weight is from 550 to 650 lbs., according to the payload carried.

• **Japan's Itokawa Laboratories** — The most impressive rocket efforts in the Orient have been spearheaded by Japan's Itokawa Laboratories, where one improved *Kappa* rocket has succeeded another. All have been successfully fired at the Akita Rocket Range.

The latest in the series—*Kappa 8*—was shown for the first time just before launching in an M/R photograph (Sept. 12, 1960, p. 43).

The two-stage *Kappa 8* reached a top velocity of 4918 mph and carried a 55-lb. payload to 124.2 miles. ⌘

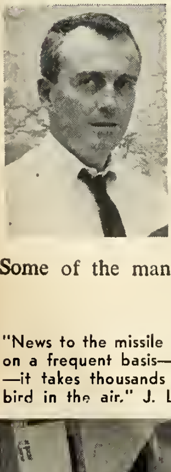
Sounding Rockets—U.S.A.

		(Less Payload)			
Vehicle and Contractor	Stages	Weight Lbs.	Height Ft.	Performance Claimed (Sea Level Launch) (*Actual attainments)	Status
Loki-Dart, Cooper Development	One solid (2000 lbs., 1.9 sec.), can be fired from 5-in. gun	23	5	*8 lbs. to 40 mi., max. accel. 200 g	Completing develop ment; Navy to fir from shipboard
Arcas, Atlantic Research	One solid end-burner (350 lbs., 28 sec.)	65	8	*6.5 lbs. to 50 mi., max. accel. 30 g	Operational; more tha 300 flown for man agencies
Weather Sounding Rocket, Rocketdyne	One solid (12.7 NS 660)	67	7	6 lbs. to 45 mi. max. accel. 30 g	Proposed
Judi-Dart, Rocket Power/-Talco	One solid (2400 lbs., 1.7 sec.)	25	5	*6½ lbs. to 60 mi. max. accel. 200 g	Operational; in use b several agencies
Hopi-Dart, Rocket Power/-Talco	One solid (3800 lbs., 3.5 sec.)	84	7	*10 lbs. to 40 mi. max. accel. 130 g	Vehicle fired withou dart
Viper-Falcon, Zimney	1. Grand Central Viper I (5.6 KS 5400) 2. Thiokol Falcon	279	12	*20 lbs. to 75 mi. max. accel. about 50 g	Two flown, three o order for Navy
Asp I, Cooper	One 5.3 KS 5800	216	9	*50 lbs. to 35 mi. max. accel. 48 g	Operational
Apache, Thiokol	One Solid (Cajun with improved polyurethane propellent)	188	9	*35 lbs. to 40 mi.	Completing development
Asp IV, Cooper	One solid (12.7 KS 2750)	208	9	25 lbs. to 90 mi.	Development
Hopi-Plus, Rocket Power/-Talco	1. Hopi; 2. Rocket Power, Hemi-Hopi (1900 lbs., 3.5 sec.)	100	11	10 lbs. to 60 mi. max. accel. 115 g	Development
Kiva-Dart, Rocket Power/-Talco	One solid Kiva (7800 lbs., 4.5 sec.)	237	9	*25 lbs. to 55 mi. max. accel. 110 g	Vehicle fired witho Dart
Aerobee 100 (Aerobee Jr.), Aerojet-General	1. Solid 2.5 KS 18000; 2. Liquid IRFNA, JP-4 (2600 lbs., 40 sec.)	1400	18	*120 lbs. to 60 mi. max. accel. 12 g	One flown; on NAS approved list. Scale down Aerobee-Hi
Arcon, Atl. Res.	One end-burning solid (945 lbs. 33 sec.)	213	13	60 lbs. to 60 mi.	Development comple but not procured; NASA approved list
Phoenix, Rocket Power/-Talco	1. Kiva; 2. Hopi	320	13	*11 lbs. to 200 mi. max. accel. 131 g	Development complet
Archer, Atl. Res.	One solid end-burning (aluminized Arcon)	About 220	13	40 lbs. to 85 mi.	Development
Aerobee 150 (Aerobee-Hi) Aerojet-General	1. Solid 2.5 KS 18000; 2. Liquid IRFNA, aniline-alcohol (4100 lbs., 50 sec.)	1900	23	*110 lbs. to 190 mi. *150 lbs. to 165 mi. max. accel. 12 g	Operational; 85 flo in 13 years; approv for NASA and services
Nike-Cajun, several manufacturers	1. Solid ABL Nike; (3 DS 50000); 2. Thiokol Cajun (2.8 KS 8100)	1350	22	*50 lbs. to 100 mi. max. accel. 52 g	Operational; on NA and Air Force approv lists; several hundr flown
Nike-Asp (Aspan 150), Cooper	1. Nike; 2. Asp I	1500	21	*50 lbs. to 150 mi.	Operational; on NA approved list; seve agencies using
Nike-Apache, New Mexico State College	1. Nike; 2. Apache	1480	21	50 lbs. to 150 mi.	Flights expected so in Army program
Skylark, Bristol	One Raven (12,000 lbs., 30 sec.)	2200	22	150 lbs. to 85 mi.	Development comple NASA to use Woomera launchings
Iris, Atl. Res.	1. Cluster of seven solids (total 18,000 lbs., 1 sec.); 2. End-burning solid (3800 lbs., 62 sec.)	1216	About 20	*150 lbs. to 140 mi. max. accel. 13 g	Development; 1 flov on NASA approved

Vehicle and Contractor	Stages	(Less Payload)		Performance Claimed (Sea Level Launch) (*Actual attainments)	Status
		Weight Lbs.	Height Ft.		
erobee 300 (Sparrow-bee), Aerojet-General	1. Solid 2.5 KS 18000; 2. Liquid IRFNA, aniline-alcohol (4100 lbs., 50 sec.); 3. Sparrow (1.8 KS 7800)	2000	27	*90 lbs. to 225 mi. *60 lbs. to 260 mi.	Operational; 18 flown; on NASA approved list
igh Altitude Sampler, RT-2 Sandia	1. Cluster of three Viper I and three Viper II (3.8 KS 8200); 2. Viper I	1620	14	*110 lbs. to 250 mi.	One flown for AEC
igh Altitude Sampler (HAS), Sandia	1. Nike; 2. Six Viper I's fired three at a time; 3. Viper I	3050	25	110 lbs. to 250 mi.	AEC flights planned
otput, Douglas	1. Thiokol Pollux (45,000 lbs., 25 sec. and two Thiokol Recruits (1.5 KS 35000); 2. Hercules-ABL Altair (38 DS 3060)	8800	25	*150 lbs. to 200-250 mi.	5 flown in suborbital tests of Echo balloon
os, Univ. of Mich.	1. Honest John (40 KS 105,000; 2. Nike; 3. Recruit or Thiokol Yardbird (3.25 KS 17000)	5400	38	*80 lbs. to 300 mi.	3 flown; Air Force adopted as standard vehicle (Yardbird version)
strobee 200, Aerojet-General	1. Nike; 2. Solid 30 KS 8000	2600	18	200 lbs. to 200 mi.	Flights to begin soon for Air Force
strobee 250, Aerojet-General	One solid Aerojet Junior (a rocket about the same size as Sergeant)	9900	19	700 lbs. to 200 mi.	Proposed
strobee 350, Aerojet-General	One solid Aerojet Senior (NASA Algol, 36 KS 120,000)	23,600	30	900 lbs. to 300 mi.	Proposed
strobee 500, Aerojet-General	1. Solid 2 KS 36250; 2. Solid 30 KS 8000; 3. Asp I	1940	21	50 lbs. to 500 mi.	Development; flight tests in progress for Air Force
go E5 (Jason), Aerolab	1. Honest John; 2. Nike; 3. Nike; 4. Recruit; 5. Thiokol T-55 (1.3 KS 4800)	About 6800	About 52	*50 lbs. to 4-500 mi.	18 fired successfully in measurement phase of Argus nuclear explosions in space; on NASA approved list but not procured now
go D4 (Javelin), Aerolab	1. Honest John; 2. Nike; 3. Nike; 4. Altair	6750	47	*50 lbs. to 7-800 mi.	2 flown; on NASA approved list; replaced Jason because achieved higher altitude
trobee 1000, Aerojet-General	1. Honest John; 2. Solid 5 KS 50000; 3. solid 30 KS 8000	7040	33	50 lbs. to 1000 mi.	Proposed
go D-8 (Journeyman), Aerolab	1. Thiokol Sergeant with two Recruits; 2. Grand Central Lance (7 KS 39000); 3. Lance; 4. Altair	13,932	62	*83 lbs. to 1200 mi.	1 flown last month in first NERV launching; on NASA approved list
ongarm, Univ. of Mich.	1. Honest John; 2. Nike; 3. Nike; 4. Yardbird; 5. JPL Baby Sergeant (5.4 KS 1700)	About 6850	About 57	*20 lbs. to 1140 mi.	Under review; 1 of 5 launchings successful in Army program
rcheron, Aerolab	One Pollux with two Recruits	10,000	20	*2200 lbs. to 50 mi.	1 flown for Air Force last month
ilblazer, NASA	1. Honest John; 2. Nike; 3. Lance; 4. Thiokol T-40; 5. Thiokol T-55; 6. Langley Res. Center 5" spherical			Mach 25 re-entry tests (Stages 4-6 fire downward)	Several fired, prime contract to be awarded soon
e Scout Jr., Aeronutronic	1. Thiokol XM-33 (Castor, 27 KS 55000); 2. Hercules X-254 (Antares, 37 DS 14500); 3. Aerojet 30 KS 8000; 4. NOTS 17-in. spherical			*32.8 lbs. to 17,000 mi.	1 flown last month (Blue Scout series is Air Force version of Scout)
out, NASA-Chance-Vought	1. Aerojet Algol (Senior)); 2. Castor; 3. Antares; 4. Altair	36,000	65	112 lbs. to 3700 mi. 150-200 lbs. in orbit	
tle Joe, NASA	1. Four Pollux and four Recruits in cluster	35,000	20	*2000 lbs. to 55 mi.	Four flown in tests of Mercury capsule
trobee 1500, Aerojet-General	1. Aerojet Junior; 2. Solid 30 KS 8000	10,500	25	50 lbs. to 1500 mi.	Development (company-sponsored); 2 to be flown
e Scout I, Aeronutronic	1. Aerojet Senior; 2, Thiokol XM 33; 3. Antares		60	500 lbs. to 1000 mi.	Development
e Scout II, Aeronutronic	1. Aerojet Senior; 2. Thiokol XM 33; 3. Antares; 4. Altair (same as NASA Scout except for addition of 4th stage guidance)	36,000	65	50 lbs. in orbit	Development

"Why do we like Missiles and Rockets magazine? The answer is simple. Missiles and Rockets deals exclusively with astronautics. Missilery and outer space exploration today is an industry by itself, long divorced from aviation," R. R. Drummond, (left), Chief, Structures Research. He is shown here with Managing Editor Howard and E. L. Strauss, Supervisor of Non-Metals Research, examining extreme high temperature test examples of ceramics and plastics being developed for re-entry vehicles.

WHY DO SO MANY KEY PEOPLE AT THE MARTIN COMPANY READ MISSILES AND ROCKETS



1,087 Paid Subscriptions! In 1959, Martin ranked sixth among all military prime contractors. Its missile/space projects included Titan, Dyna-Soar, and Bullpup, among others. Therefore, it is not surprising to find 1,087 paid subscribers to M/R concentrated at Martin. And since many M/R subscriptions have high pass-along readership, M/R penetration involves many times that number of readers.

Some of the many reasons why M/R commands intense readership at Martin are given in the picture story. They were obtained as a result of a recent visit to the company by M/R Managing Editor, William Howard (insert).

These comments and those of other key readers in missile/space companies show again what M/R has known all along . . . that the missile/space industry is an industry by itself, complete and distinct from aviation . . . with rapidly changing requirements that demand *undiluted, weekly* technical/news reporting. Missiles and Rockets deals *exclusively* with this market—and the deep, penetrating readership and acceptance it has earned document its leadership in the missile/space field.

"News to the missile engineer must be news and must be technical . . . on a frequent basis—not a month old. From concept to proven flight—it takes thousands of parts from hundreds of companies to put a bird in the air." J. Lennard, Scientist, Research and Development

"Today's missile and astronautics engineer must know the products and capabilities of the other companies throughout the industry. Here's where Missiles and Rockets magazine fills the bill."—R. Allen, Scientist, Cryogenics, Research and Development.

Technical Countdown

ELECTRONICS

utomatic Defense System Studied

Work has begun on applied research program aimed at an ultimate combat operations control system to provide U.S. decision-makers with continuous evaluated data on potential enemy strength, intent, and actions, and proper counter-actions. Initial contract for $392,090 was awarded General Electric's TEMPO by ARDC.

ew Coding Techniques for Space

More efficient and sophisticated coding systems may be the answer to long-range space communications with reasonable transmitter powers. According to Kenneth Uglow, EMR/ASCOP, such methods would bring data transmission closer to theoretically ideal efficiencies.

ilitary Electronics Growth to Drop

A decrease in the present rapid growth rate of military electronics is predicted by Electronic Industries Association. They say annual increases will run only about 8-10% during the next 5-10 years.

ansistors Out for Nuclear Instrumentation?

Transistors are too susceptible to radiation effects to be used in instrumentation of nuclear-powered spaceships, according to some involved in atomic work. Even with reasonable shielding or distance-isolation, they feel, radiation levels would still be too high for reliability.

laris Guidance to be Minified

Navy's goal in miniaturizing *Polaris* IRBM guidance reportedly is to produce a 40-lb. package. Present system weighs roughly 250 lbs., but MIT's Dr. Charles S. Draper says the 1500-mile A-2 *Polaris* will carry a considerably smaller system.

easurement Facilities Rival NBS

A new engineering measurement standards lab at Douglas Aircraft's Santa Monica Div. is said to be second only to the National Bureau of Standards in facilities for its three fields of interest: microwave transmission, fluid pressures, and ac and dc circuits. In radio-frequency measurements from 10 mc to 40 gc the lab will have an accuracy capability of ±5 parts in 100 million, says Douglas.

ermoelectric Space Power Next

Nine hundred ganged aluminum concentrators, assembled in groups of 28 and occupying 100 sq. ft., will be used by Hamilton Standard for its prototype 100-watt solar space-power system. Being designed under an Air Force WADD contract, the test model will use the 4-in.-dia. collectors to focus sunlight on thermocouples. Estimated temperature may reach 1000°F at heated end and 400°F on low end. A 1500-watt follow-on prototype will use 7000 reflectors over 700 sq. ft.

ectronics to Extend Man's Brain

Intellectronics—extension of the human intellect by electronics—will become our greatest occupation within a decade, according to Dr. Simon Ramo. "Increasing the nation's brain power (by electronic aids to education and machine augmentation) is even more urgent for our national position and for the welfare of civilization than space conquest," he says.

GROUND SUPPORT EQUIPMENT

LARC's Assigned to Project Mercury

Three of Army's LARC amphibious lighters have been delivered to Canaveral for use with Project *Mercury*. The crane-equipped lighters will be used to recover any capsules that fall short and impact in the surf or marshes around the Cape.

'GSE' On Way Out?

Air Research and Development Command is changing to ASE (aerospace support equipment) as a more inclusive and descriptive designation for weapons system support equipment.

Super-Speed Wind Tunnel for Space Research

Prototype model of a plasma-jet wind tunnel expected to produce continuous speeds of 18,000+ mph and temperatures of 25,000°F was displayed at the AFA Aerospace Panorama. The XFA (crossed-field excitation) tunnel is under development by Allis-Chalmers and MHD Research Inc.

'Cool Suit' Developed for Fuel Handlers

A transparent protective suit with built-in air conditioning for handlers of missile fuel and others in hazardous environments has been demonstrated by Bendix Corp. A shoulder pack provides oxygen for breathing and cooling.

MATERIALS

Copper: Indispensable for Power Tubes

Copper accounts for up to 90% of all material used in its klystron tubes, says Varian Assoc. Using nearly a half-million pounds annually of OFHC—oxygen-free (99.99% pure) high-conductivity copper made only by American Metals Company, Ltd., the microwave-tube manufacturer considers the material so essential to its operations that it keeps a constant reserve of from 50,000 to 75,000 pounds in stock at all times.

Materials Research Division Formed at NASA

A new office, presided over by George C. Deutsch, will establish areas and levels of materials research and development appropriate for direct support in and out of the National Aeronautics and Space Administration. The division, which will maintain a continuing review of materials requirements, is evidence of NASA's recognition of the importance of materials research.

PROPULSION

4000-year Orbit Life

After pushing *Echo* into orbit, the burned-out *Thor-Delta* third-stage rocket settled into a nearly circular orbit of its own. Douglas scientists estimate that the Allegany Ballistics Lab's *Altair* will circle the earth until about the year 6000 A.D.

Air Force Plant 78 Gets Funds

Continuation of work on the *Minuteman* first-stage engine production facility is the announced purpose of a $17-million Air Force award to Thiokol Chemical Corp. The plant will ultimately cost $30 million. The present fund is in addition to an earlier $1 million assigned for preparatory work.

300-kw Thermionic Generator by '67?

AEC thinks it could produce such a system in seven years—but neither NASA nor DOD has ordered development

by William Beller

THE ATOMIC Energy Commission believes that starting today it could produce a 300-kilowatt nuclear-powered electrical generator—with no moving parts—for space use inside of seven years.

So far, however, neither the National Aeronautics and Space Administration nor the Department of Defense has put down a requirement for this long-leadtime item which could be urgently needed for space programs in the late 60's.

Largest nuclear-powered generator being developed now is the SNAP 8 turboelectric device, which will put out 30 kilowatts at a specific weight of 50 pounds/kilowatt.

The 300-kilowatt generator would be a thermionic one, using electrons for its working fluid.

It would weigh less than seven pounds a kilowatt; refinements would probably bring this figure down to four pounds per kilowatt. Thus, the eventual system weight would be about 1200 lbs. Such a system could provide a powerplant having the capability for interplanetary operations.

Next year the AEC probably will release a practical curium-242 thermionic system rated at a few watts and weighing less than a pound. This indicates that the technology of the thermionic generator is now fairly well unde stood. This small power system wou be useful in probes for communic tions and scientific work.

If a stumbling block remains in t way of making higher energy ther ionic converters, it is the problem getting fuel-element materials that w withstand the elevated operating tem eratures needed for a lightweight s tem.

• **The ideal generator**—The b electric generator for space w should have high power and ener densities. These should be, respective more than 0.1 kilowatts per pound system weight, and 0.2 kilowatt-ye per pound.

Next, the system should have long and uneventful life, be compati with the space environment, and h no feature that would disturb the hicle in which the electric genera functioned or harm personnel, in event that the vehicle is inhabited.

These features imply system quirements such as the following, s Lt. Col. G. M. Anderson (USAF), AEC's Chief of Systems for Nucl Auxiliary Power (SNAP):

–Operation at high temperature that waste heat can be rejected fr a small-area radiator, and theref from a lightweight one.

–Use of a fuel material with h energy-density—such as stochiome uranium carbide to be used in a sn compact fast reactor. The reactor sho be able to fission a relatively large nu ber of the atoms in the fuel.

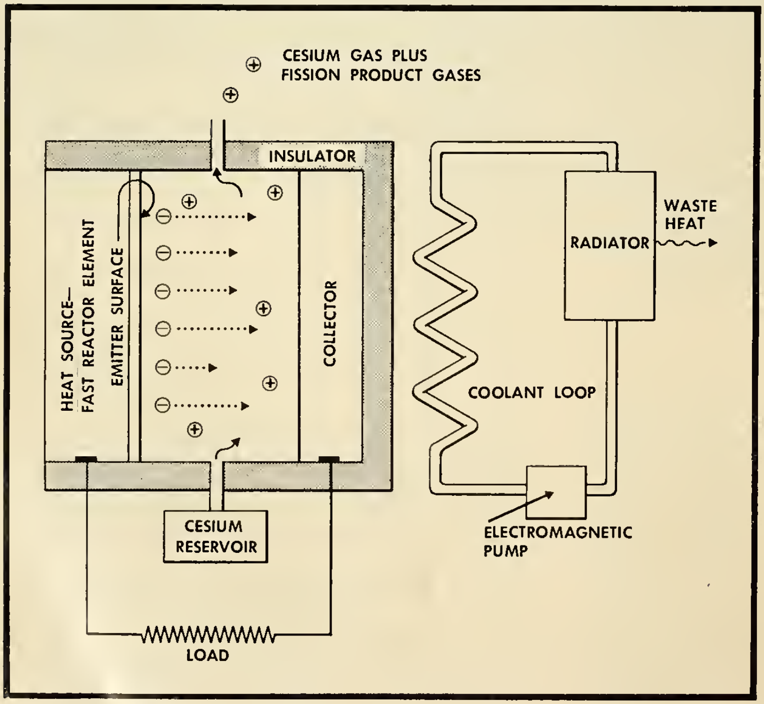
–Shielding integrated into the tem to get the smallest overall wei

–Equipment that is rugged and liable.

–The smallest number of mov parts.

–Small or no heat transfer to vehicle.

• **Nuclear diode called best**— modest powers, the thermionic gen tor seems to be the energy source able to satisfy the set of requireme Low power units, those up to about



IDEALIZED DIAGRAM of thermionic generator. Electrons are boiled off the emitting surface by a nuclear heat source, migrate to collector, and from there go through the load back to emitter surface. Cesium gas minimizes space charge and acts as a flushing agent for fission-product gases. Coolant loop absorbs waste heat from collector.

ectrical watts output, would use a dioisotope heat source; larger units, ose from a few hundred watts out- t and into the megawatt range, would e a small compact reactor.

The cycle of the thermionic con- rter can be compared with the me- anical engineer's Rankine cycle, in ich a working fluid such as water is ated, changes to a gas, does work, d is condensed. In the converter, a rking fluid of electrons is heated, iled off, condensed, and does work. e analogy suffers from one permuta- n: the working fluid of electrons es its work after the condensation.

The converter consists of an elec- on emitter or cathode, a space through ich the electrons flow, and an elec- on collector or anode. Electrons with- the cathode are heated either by otope decay or nuclear fission to an ergy level high enough to boil them , that is, to a point above the sur- ce work function.

The electrons migrate across the erelectrode space and are collected the anode, which has a work func- n less than the cathode. The electron eam then completes the cycle by wing through an external load.

This description omits an obvious tical point—the nature of the inter- ectrode space. Here, two views have en taken: in the first, the electrodes very close together; in the second, spacing is held moderate and an ized gas is introduced. It now ap- ars that fairly close spacing plus an ized gas such as cesium will yield best results.

The prime function of the cesium to reduce the space charge, in effect, act like a space-charge grid. Secon- rily, the gas functions as a flusher for ding the interelectrode space of fis- n-product gases. If left alone, these es would coat the collector and nificantly reduce the converter's pow- output.

• **Who's in the field**—Typical work the close-space vacuum-type diode the SNAP program has been con- cted at the Thermo Electron Engin- ing Corp. (TEECO) of Cambridge, ss., under the direction of Dr. orge Hatsopoulos, the company's sident. Work on the cesium-vapor de for the SNAP program has been ried out by Dr. Ned Razor of omics International.

"Each of these investigators has de significant contributions toward eloping the thermionic converter and ning its theory," says Anderson.

At the same time, work has been ng on at The Martin Co. in develop- isotopic heat sources. In a parallel dy, Atomics International has been estigating the compact reactor as a heat source.

"Grossly Inadequate?"

"The fact of the matter is that there is . . . no policy for utilizing nuclear power resources (for space applications).

"Not only is it important to note that there is no specific program but the development of a 30-kilowatt unit is grossly inadequate for the 1960's. As I said earlier, nuclear electric power sources in the range of 1 megawatt are needed, that is, 1000 kilowatts as compared to 30."

Statement by Senator Clinton Anderson before the U.S. Senate on Sept. 1, 1960

A number of other organizations are doing government-sponsored work on the thermionic generator. They include: Los Alamos Scientific Laboratory, General Atomics, General Motors, General Electric, Radio Corporation of America, and the Massachusetts Institute of Technology.

• **A working model**—Teeco has made a two-stage isotope-heated thermionic generator in the form of a cylinder. It has a close-space vacuum diode at each end face. This is a demonstration model.

The housing is made of titanium. Three sapphire rods maintain an interelectrode spacing of about 30 microns. The emitter is a Type "B" Phillips cathode (barium-strontium-carbonate impregnated tungsten); and the collector is a coated molybdenum piece. The vacuum is improved by a getter.

A critical step in fabricating the model was the simultaneous accomplishment of emitter activation and coating of the collector surface to obtain the proper work functions.

The test results are as follows: upper cell—emitter temp., 2100°F; max. power, 0.35 watts; potential, 0.35 volts; and work function, 2.239 volts. Lower cell—emitter temp., 2200°F; max. power, 0.175 watts; potential, 0.30 volts; and work function, 2.594 volts.

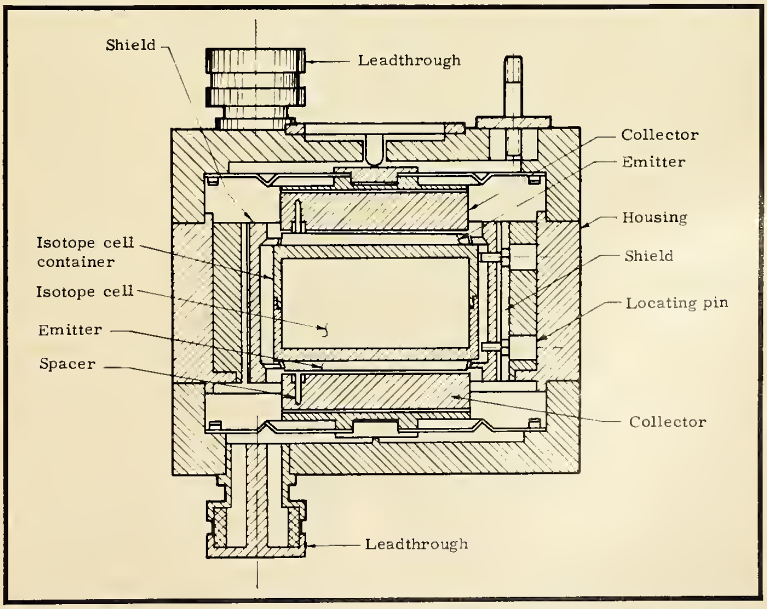
A second isotope-heated demonstration model is being built by the company. This unit will probably be fueled with curium-242 and is expected to include enough improvements and additional energy to bring the output up to four watts.

If such a unit could be built with a lifetime of one year, it would be equivalent in energy content to a ton of nickel-cadmium batteries. (Such a battery is assumed to have about 20 watt-hours of energy per pound.)

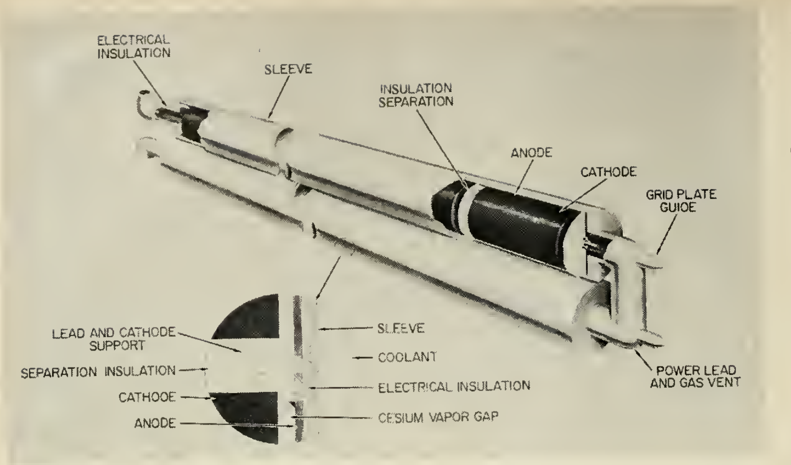
• **Selecting the reactor**—In general, the reactor chosen for thermionic converter applications should operate at a high temperature for an extended period. This permits long operation combined with small radiator weight.

If possible, the coolant loop should be eliminated. If this is not feasible, the waste heat from the collector and other sources should be removed by a liquid metal circulated by an electromagnetic pump.

The reactor should be kept as small



CROSS SECTION of two-stage close-electrode thermionic generator being developed by Thermo Electron Engineering Corp. Estimated operating characteristics: emitter temp., 1500°K; power output, 4 watts; overall efficiency, 4%; and total weight, 9 ounces.



THERMIONIC CONVERSION fuel element. By a series connection of the stages within the fuel element—making the cathode of one stage the anode of the next—the voltage can be built up.

as possible, to hold down shielding weight and complexity.

The reactor should be of reasonable cost. This means there should be a low investment in fuel. Thus, if a fast reactor is used, U-235 should be considered, rather than the more expensive U-233 and Pu-239. These latter two elements are also potentially more hazardous than U-235.

In brief, here are some of the characteristics and objections to possible thermal reactor systems:

(1) Water-moderated. Small core, incapable of high-temperature operation.

(2) Hydride-moderated. Small core but hydrogen dissociates and is lost through any known cladding at typical operating temperatures.

(3) Beryllium moderated. Larger core than (1) and (2) but has poor physical properties at elevated temperatures, and melts at 2240°F.

(4) Beryllium-oxide moderated. Larger than (3) but strength properties hold up better than (3) at elevated temperatures.

(5) Graphite-moderated. Excessive size. Strength and other physical prop
erties show up well at elevated temper
tures, even over 4000°F.

The fast reactor system as oppose
to the thermal permits a wider sele
tion of materials favorable to solvin
converter problems. Also, the long mea
free path of the fast neutron help
avoid local power reactions in a many
celled thermionic unit. Here are som
of the characteristics of fast reacto
systems:

(6) Liquid-metal-fueled. Low fu
loading, but operational and materia
problems are severe. Reactor is small
than (1) through (5).

(7) Uranium-carbide-fueled. Has
reasonably low critical mass for a rea
tor of this type. Physical properties ca
be improved by adding other refracto
carbides such as zirconium carbide.

(8) Uranium-nitride-fueled. Slight
smaller reactor than (7) but physic
properties are not as well known.

• **Selecting a radioisotope** — On
two isotopes appear to be suitable f
use in a thermionic converter: curiun
242 and plutonium-238. The one co
sidered by AEC to have the most pron
ise, chiefly on the basis of safety,
curium-242; this is being selected f
development into hardware.

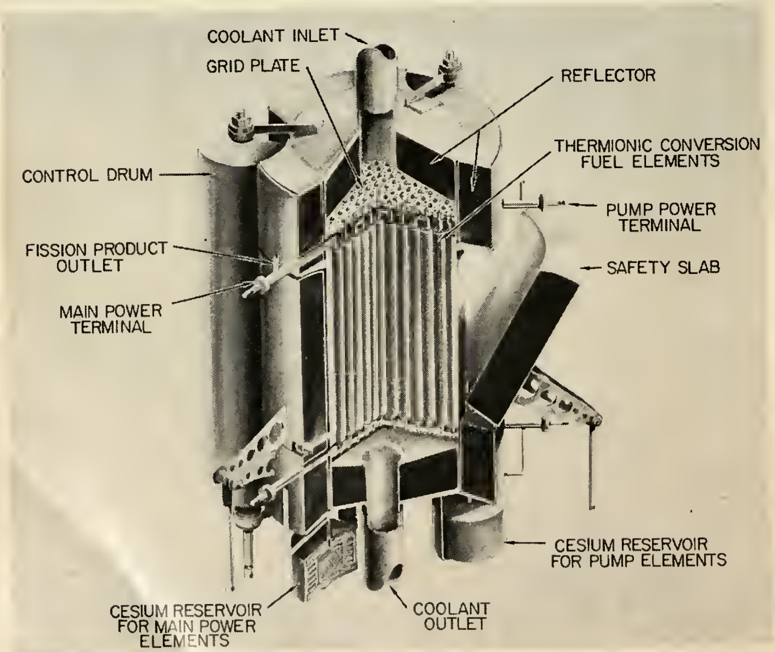
On the basis of economy, the ar
ficial and the fission waste isotopes a
inviting. Of these, curium-242 in t
compound form Cu-242-Ni has a ma
mum power density of 810 watts/c
cm, a half life of 162 days, and is
alpha emitter.

Alpha particles are, of course, t
easiest to shield. The disadvantage
such radiations is the vapor pressu
they build up, which in the instance
close-space electrodes could pose di
cult design problems.

Too short a half-life results in
complicated design; too long a h
life results in a low power density.
least 100 days half-life is desirable.

Thus the features of an isotope t
make it suited for thermionic use
easily stated: high power density, m
erate half-life, low cost, good avai
bility, low shielding requirements, a
low vapor pressure.

When really high electrical pow
are needed, those of the order requi
to give thrust to a spacecraft, th
turboelectric or thermionic nuclear s
tems in the high temperature ra
have to be used. Only the 30-kilow
turboelectric system is under act
AEC development (M/R, Aug.
1960, p. 39). Yet if a static source
reliable and long-time high power w
high specific power and energy dens
is wanted, then the reactor-powe
thermionic converter in the foreseea
future would appear to have the mar
to itself.



THERMIONIC REACTOR. Groups of fuel elements can be connected in series thereby yielding the desired voltage output.

C-E-I-R Gets First IBM STRETCH

NEW YORK—The first IBM TRETCH-class computer for commer-al use will go to C-E-I-R, Inc., of Ar-ngton, Va.

Capable of 75 billion computations day, the custom-engineered IBM-7030 ata Processing System represents e ultimate in computer technology ithin the present state of the art, ac-ording to International Business Ma-ines Corp.

So versatile is this ultra-high-speed stem that whole complex problems eviously impractical or impossible to lve will be processed rapidly and onomically. IBM says this "total ap-oach" to problems adds a new dimen-on to scientific problem-solving.

Announcement of the contract sign-g was made jointly in New York last eek by the two firms. Delivery of the stem is scheduled for 1962. It will be stalled in C-E-I-R's new Los Angeles search center.

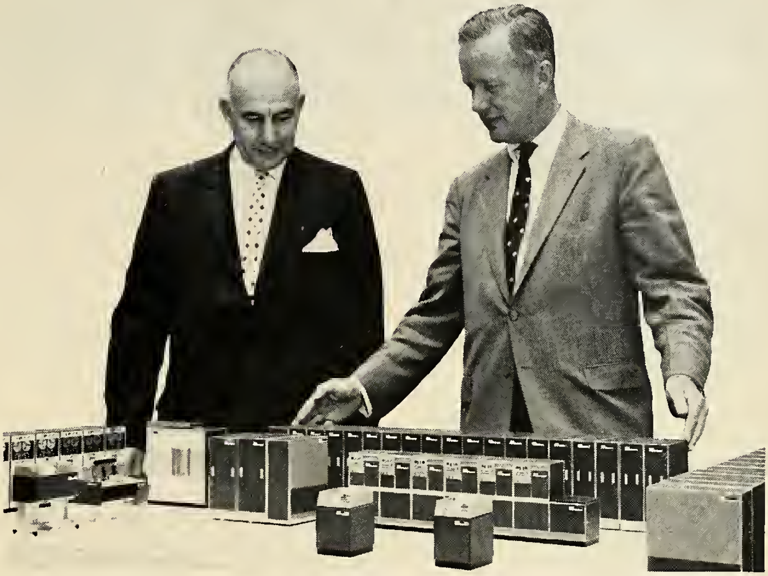
A remarkable sidelight to this ven-re is the fact that the value of a TRETCH complex is more than ouble C-E-I-R's current annual gross $6 million. Monthly rental for the stem, said IBM, is over $300,000.

• **Sign of confidence** — C-E-I-R ecializes in providing research and mputer services to both industry and e government. Already the largest in-pendent company of its type in the S., the six-year-old corporation has own very rapidly. Its average annual owth has been about 65%; this has en maintained largely on the strength a continuous sharply rising sales rve and more recently by merger with eneral Analysis Corp. of Los Angeles July and with Engleman & Co. of ashington last week.

Signing of the new contract for TRETCH is even more pointed evi-nce of the company's confidence in continued development and progres-e expansion.

Full significance of what a commer-lly available STRETCH facility will ean to both C-E-I-R and its West ast clients is best shown by the capa-ities of the system itself.

The fully transistorized IBM-7030 a rapid-access system that achieves 2-million computations/sec. rate ough the principle of simultaneous eration. That is, its six-magnetic-core rage units can be operated at the ne time. Data retrieval from storage uires 2.18 millionths-sec.



TYPICAL STRETCH-TYPE data processing system configuration is demonstrated with these models by IBM's DP Division President G. E. Jones (right). C-E-I-R's president, Dr. H. W. Robinson, has just signed a contract to lease the IBM-7030 complex for its Los Angeles research center for "over $300,000 per month."

A radically advanced random-access magnetic-disk storage is employed. Over 1.25-million alphabetic characters can be stored or retrieved from the disk storage in 1 sec.

A specialized computer, called the Exchange, within the system serves as a switching center to assure peak efficiency in handling input-output devices. The exchange controls data transfer between 32 separate channels and the main core storage. All sections operate simultaneously.

Another unit in the system boosts effective memory speed by anticipating instruction and data requirements. Acting as a reservoir, it lines up instructions and data a fraction of a second ahead to permit process continuity to the arithmetic and logical unit.

A temporary interrupt also is possible in system operation to permit priority data processing. All other parallel functions, however, can continue without a break.

• **Far faster than earlier systems**—The system, says IBM, has more self-checking and self-correcting capabilities than any other data processing system today and is compatible with all other equipment employed with previous IBM computers.

Seventy-five times faster than the well-known IBM-704, STRETCH will occupy about the same area of floor space—2000 sq. ft. The system is 15 times faster than the highly touted 7090, recently introduced.

The startling speed of STRETCH is expected to result in an extremely low unit cost of work performed, according to C-E-I-R. It is this virtue that can make such a costly rental system pay off for the company.

Success of the operation can only be assured if C-E-I-R can provide high accuracy and faster solutions for clients at costs well below those incurred with their own lower-capacity machines.

IBM feels its new system offers all of the characteristics necessary to meet these demands.

The system was designed to handle inputs and outputs from remote stations. C-E-I-R's L. A. facility will be equipped with data links to the offices and plants of all of its future clients and to other C-E-I-R research centers. All of the necessary programers, analysts, and other professional personnel will be provided by the firm at the center to support customer services. ⁑

Photometric System Boosts Tracki

Monitoring assembly developed by OPTOmechanisms, Inc., for Air Force makes highly accurate velocity readings, will enhance cameras

by Charles D. LaFond

A NEW PHOTOMETRIC monitoring system for recording light reflected from a tumbling satellite has been developed to derive angular velocities with great accuracy. It is currently being tested by the Air Force's Cambridge Research Center.

Designed originally for use in correcting tracking-antenna alignment and for visual observation of satellites, the compact lightweight system has been tested successfully both at Cambridge and Patrick Air Force Base in Florida.

The system developed by OPTOmechanisms, Inc., of Mineola, N.Y., may be used for detection of objects in space, velocity measurements of missiles and rockets, measurement of background illumination and celestial observation and navigation. It can obtain readings accurate to 1 part in 1000 or better.

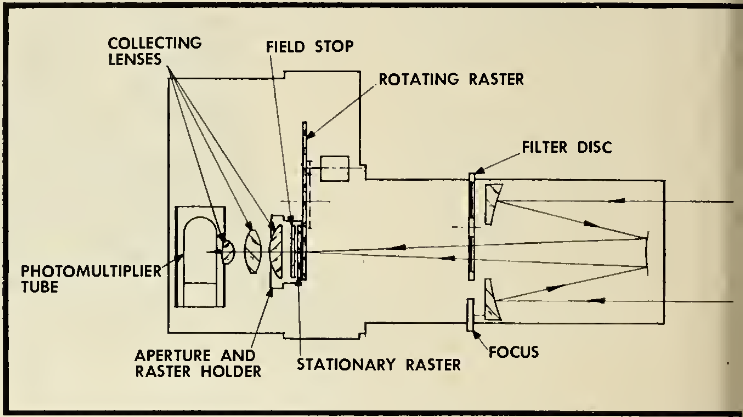
Use of such a system will enhance the effectiveness of ballistic cameras for satellite observation.

The system is portable, carries a spotting telescope for boresighting and visual inspection of the field of view. Total weight of the system is 62.5 lbs. Extremely versatile, the photometric system employs interchangeable lenses from 12-in. to 80-in. focal length and also permits interchangeability of detectors for infrared, ultra-violet, or the visible region.

Mechanically it is designed to be used on a stationary mount where signals can be recorded when an object traverses the field of view, or it can be supported on a radar tracking system or theodolite for measuring illumination intensity. The system includes a control box and strip-chart recorder capable of handling two channels.

System threshold sensitivity based on tests so far have found it to be equivalent to an eighth magnitude star during the dark portions of the twilight.

Detection of first magnitude stars was achieved during the full daylight region while second and third magnitudes were detected during limited daylight. This was over a 1° field of view for daylight operation and a 5° or larger field of view for twilight detection. Increasing the diameter of the objective automatically provides higher sensitivity.



OPTICAL SCHEMATIC diagram of the telescope assembly used in OPTOmech nisms' Photometric Monitoring System.

- **15.5 lb. telescope**—The photometric system is comprised of two major subsystems: the telescope and the recorder control box.

The telescope subsystem is a 15.5-lb. electro-optical assembly containing the optics and a photo detector. The telescope is a 25-in. focal length reflecting system and it has a focusing adjustment knob and filter wheel containing 4 filters that can be inserted in the field of view at will. An adapter ring is included which allows for the interchangeability of the telescope.

The spotting scope provided on top of the subsystem is used for alignment and viewing and permits variable magnification from 2½ to 8 power. It provides tapered cross hairs for boresighting.

The 47-lb. recorder-control box subsystem permits remote operation of the telescope assembly. Its two-channel recorder (Brush Instruments Mark II) is a pen-type containing variable speed paper drive, 2 dc amplifiers, and 2 event markers for time reference.

In the control portion of the ele tronics assembly is included a prote tion circuit for the photomultiplier th automatically removes high volta from the photo tube and energizes warning light when the telescope pointed at a high source of illumin tion, such as the sun or moon.

- **Optical configuration**—Reflecti optics in the telescope collects light lumination from the sky and focus it in the plane of a rotating raster. T raster disc is driven by a synchrono motor through a gear reducer. Bla and transparent wedges equally spac throughout the raster are provided.

The image will appear as appro mately a point on the raster. Consta rotation of the raster lines causes modulation of the illumination of t point image with a frequency roughly 2 kc. The image, followi modulation, passes through a station raster containing black and transp ent lines 0.004 inch thick.

The image is somewhat smaller th the raster line thickness and as it pas on the raster its light is modulated a frequency dependent on the rate travel of the object. Raster lines adjusted such that they are perpend ular to the path of the object.

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equivalent to 1.1 min. of arc. Thus, a satellite travelling at the rate of 50 min. of arc per second would have a resultant frequency of modulation of 4.5 cps.

If the telescope assembly is mounted on a continuously rotating mount the stationary raster is removed.

An interchangeable aperture can be placed behind the stationary raster to decrease the field of view of this system, and variable field stops are supplied from ¼ degree to 5 degrees in addition to rectangular apertures of ½ degree by 2½ degrees or 1 degree by 5 degrees.

Collecting lenses located between the focal plane of the scope and the photomultiplier tube gather light rays from any point within a maximum of 5° field of view and present them on a ¼-in diameter circle at the photo cathode.

Light rays from a point source are defocused when they arrive at the cathode to minimize output variations due to the varying sensitivity of the photo cathode. To reject a majority of noise components the signal received by the photomultiplier is filtered first by a -kc filter. The signal is then amplified and connected to a cathode follower. Thus, output of the telescope subsystem is of low impedance reducing noise and pickup signals and allowing the use of a remote control system.

• **Silent sensitivity**—According to its developers, the system employs circuit parameters in the photomultiplier such that the only major noise source is the shot noise caused by sky currents, and thus, the very high sensitivity achieved in the system.

A number of noise rejection techniques have been employed to minimize noise degradation. For example, when mounted on a continuously tracking mount the system employs a field of view as small as practicable to minimize the possibility of observing a bright star.

Minimum field is determined by the tracking mount. Thus, if its inaccuracy is 5 min. of arc, then the minimum field of view is 10 min. of arc.

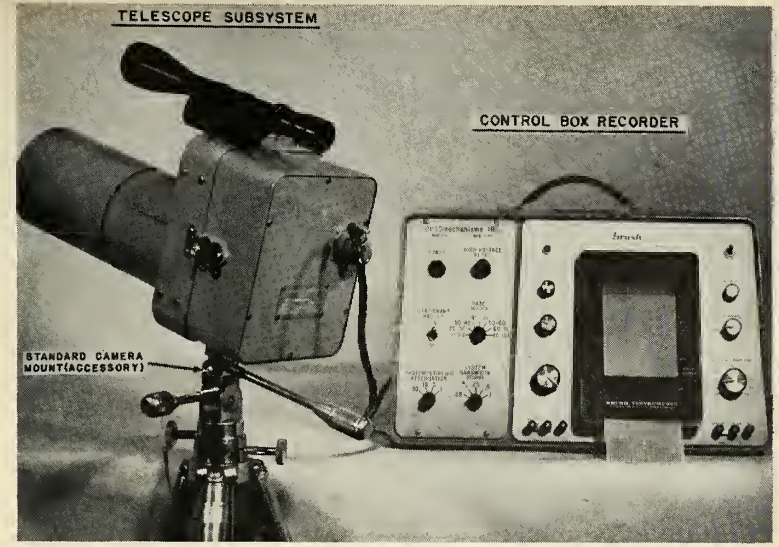
Recorded star signals are reduced by the integrating nature of low-pass electronic filters, having a variable time constant from 0.05 to 1.0 sec. Therefore, when following an object such as a satellite, the duration of an interfering star's signal may be very short and thus its effect will be negligible due to the low-pass filtering circuits.

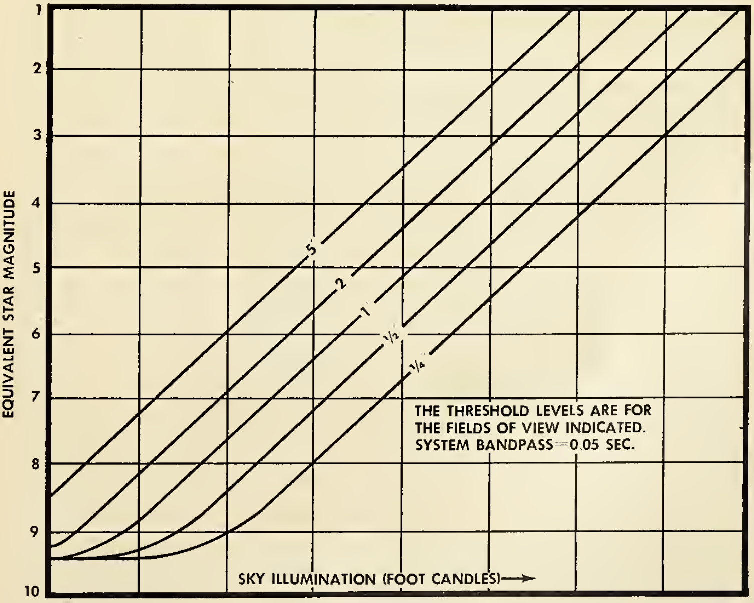
When the telescope's operational mode is stationary, rejection of star signals is accomplished more readily by the use of the stationary raster. Slow moving objects such as stars, haze or varying sky illumination are rejected since they do not produce the secondary modulation frequencies caused by the fast angular rate of the satellite being observed.

Through the use of 2-kc electronic filters microphonic noise as well as amplifier flicker are minimized by the use of a 2-kc carrier frequency.

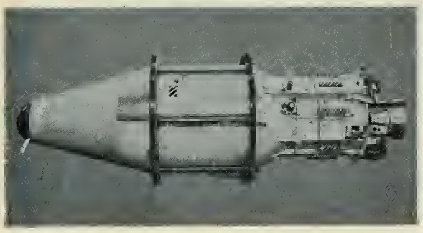
Photo-tube noise generation has been minimized through the use of less than 900 volts for the multiplier power supply.

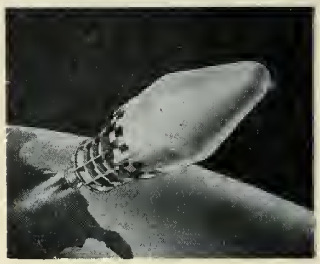
Such a photometric monitoring system eliminates the need for human visual observation. This of course in-





SYSTEM LIMITATIONS are indicated by these computed threshold sensitivities for various angular fields of view as dependent on the sky illumination levels.





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creases the reliability and performanc of a ballistic camera by having a shutter dependent on the actual amoun of light reflected by a satellite.

• **Automatic record**—The operato no longer observes the sky. Beside the permanent record displayed by th recorder of reflected illumination vs time, output also is available as a high level signal of low impedance. Thi can be used to control the grid of thyratron to change automatically th timing of a camera shutter, varying i in a programed manner to correspon with the intensity of satellite-reflecte illumination.

Employed in this manner the system is fully automatic, wherein the shutte is opened automatically to a relay whe the satellite enters the field of view an is then energized in a coded fashio to correspond with the satellite's reflected illumination.

During the dark portion of a satellite's travel, the shutter will remai closed until the satellite's signal reache a predetermined level which can be se by the operator.

In the past, when satellite observations were made with a ballistic camera the shutter was automatically or manually opened and closed in a coded fashion, but when a fast tumbling satellit passed through the field of view man problems arose.

A large number of coded shutte operations cannot be observed on th ballistic plate during the dark perio of a satellite's motion. Thus, the automatic code is ineffective when the dar period of a satellite is appreciable. Manual shutter operation is almost mand tory thus requiring actual visual obse vation.

Under these circumstances, opt mum performance is not likely.

Also, when a satellite's illuminatic is too weak or is not visible, great difficulties are encountered in manual tracking a satellite with a telescope determine the dark and light portion of the space vehicle's travel.

With OPTOmechanisms' new sy tem it is believed that even satellit of extremely low reflected light m now be monitored and recorded f subsequent analysis.

First development contract for $2 000 was let in June 1959 for a prot type based on AF-Cambridge specific tions. OPTOmechanisms added se eral features, including the daylig application and delivered the first equi ment in six months.

Two have been delivered to d for test and evaluation. Reportedly, the subsystem is accepted by the Force, another 20 will be ordered the end of this year for installati around the country.

Nucerite Shows 'Impossible' Resistance

A FAMILY OF ceramic-metal omposites developed by Pfaudler Co., ochester, N.Y., division of Pfaudler ermutit Inc., promises to solve many gh-temperature corrosion and erosion roblems.

The composites consist of a ceramic mponent (Nucerite) physically and emically bonded to structural metals ch as steel, nickel-based alloys or the ore refractory metals.

Nucerite formulations have resisted tack by corrosive vapors at 1300°F, d it is expected that this temperature ill soon be exceeded by several hun-ed degrees.

Nucerite's other physical character-ics are equally impressive.

The ceramic component in rod form thstood more stress without perman-t deformation than mild steel. A test mple, 0.020-in. ceramic on 0.5-in. el plate, took a 1200°F instantaneous mperature differential without visible mage.

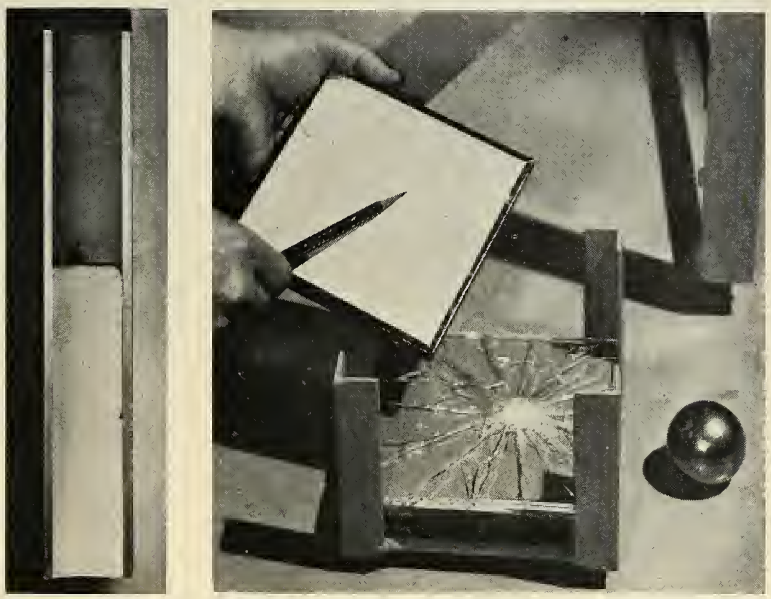
Nucerite has protected molybdenum om oxidation in a 1600°F oxyacety-e flame. A .22 caliber rifle, fired from distance of 25 ft., left a small crush ark on the 0.020-in.-deep surface of a cerite panel—without exposing the se metal.

According to Pfaudler, the unique operties of Nucerite are the result closely controlled nucleation and stallization within a ceramic formu-ion. Agents are used which act as nters of nucleation during a heat-ating cycle. The final structure con-ns a large number of very small stals.

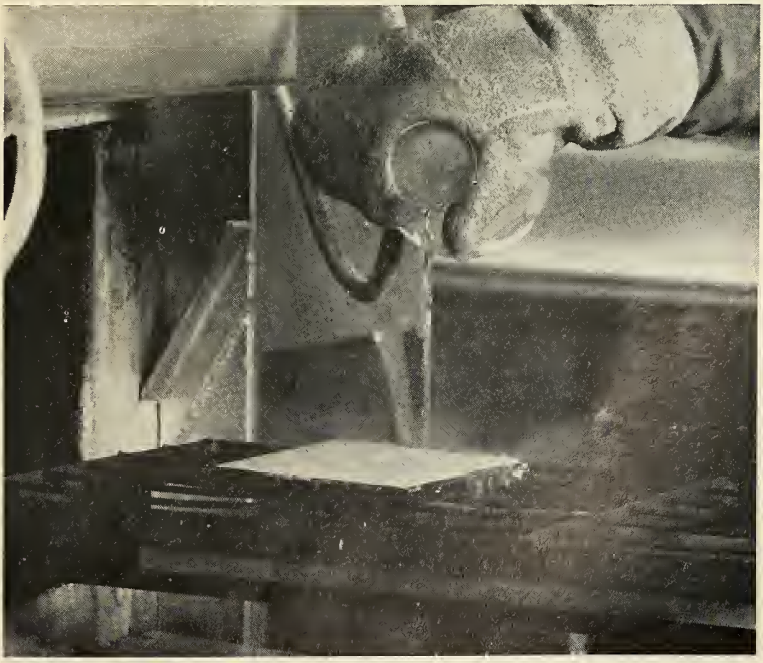
• **Base metal application**—The cer-ic formulation is sprayed on a ound-coated metal. This composite heat bonded and results in a glassy ating. A series of critical time-temp-ture operations complete the Nucer-process. Once applied, the coating xtremely difficult to remove.

Nucerite is still in the develop-ntal stage although small reaction sels and heat exchanger parts have n treated. Company spokesmen say t a considerable amount of effort is uired before the Nucerite process be transferred to full-scale produc-n.

The idea of such coatings was ned "impossible" as little as three rs ago by some leading ceramic ex-ts. Pfaudler has filed patent applica-s on the development. ⁂

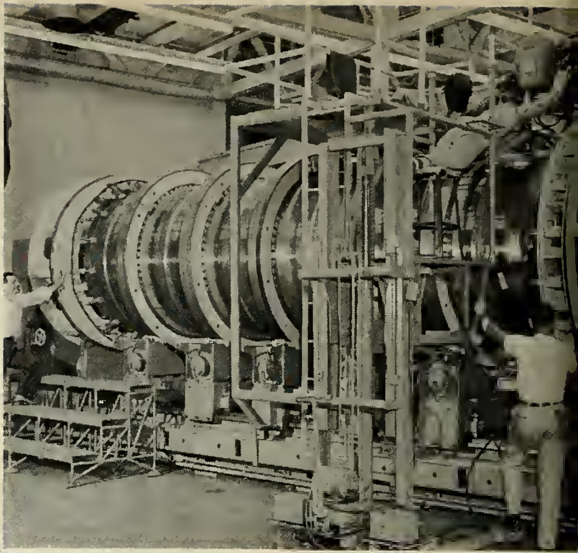


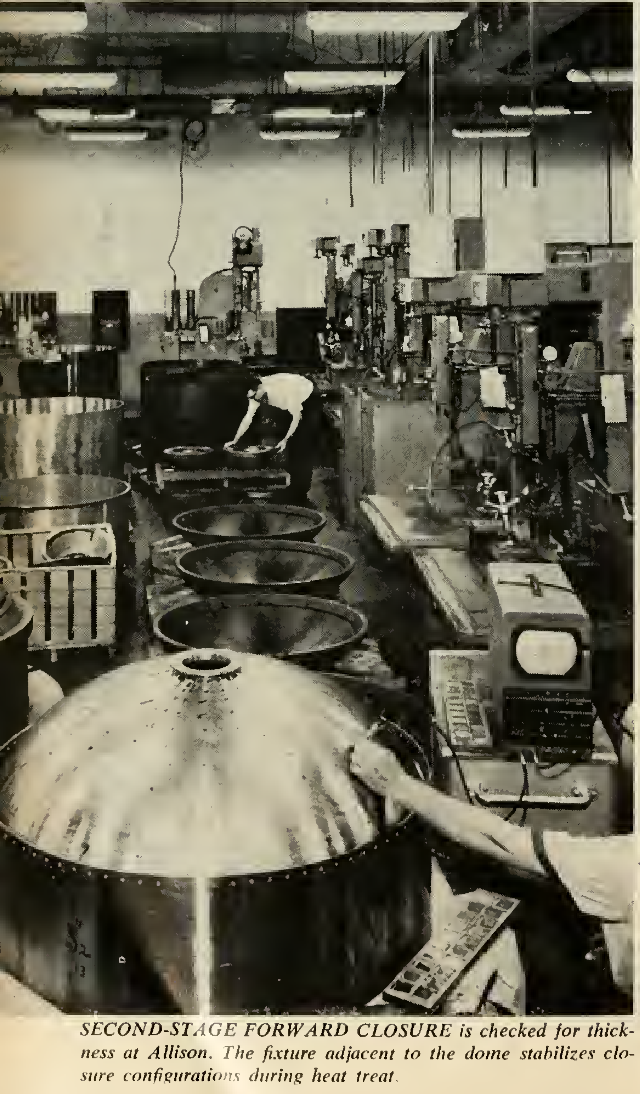
HYDROGEN CHLORIDE GAS at 1200°F corroded the metal portion of a nickel-base alloy pipe while the Nucerite area remained unaffected. On the right the 10.8-ft./lb. impact of a steel ball left the Nucerite surface slightly crushed. The shattered safety glass, 3/8-in. thick, took the same impact force.



THERMAL SHOCK of 1200 FΔT, caused by pouring ice water on a Nucerite plate at 1250°F, resulted in no visible damage to the ceramic coating.

Fabricating Minuteman Cases At Allison





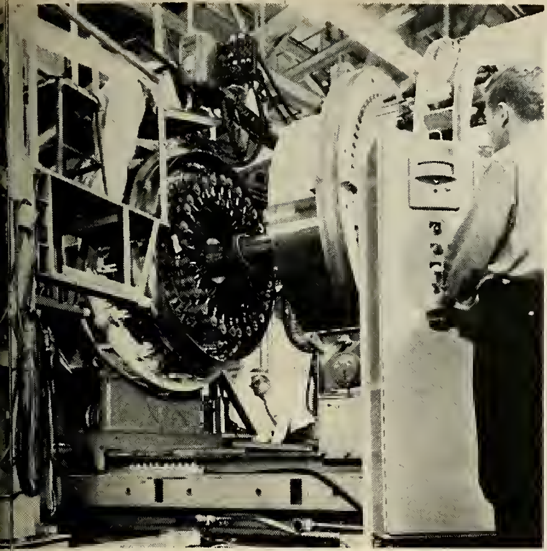
SECOND-STAGE FORWARD CLOSURE is checked for thickness at Allison. The fixture adjacent to the dome stabilizes closure configurations during heat treat.

STARTING WITH high-strength steel ring and dor forging, Allison Division of General Motors is turning c first-stage *Minuteman* motor cases in a series of massi machining and welding operations.

Developed by Allison for Thiokol, the cases ha achieved 100% reliability in all silo and test firings to da From the beginning, Allison has been using an extrem "clean" steel. Precise controls from the formation of t ingot to the finished cases has produced a high uniform of tensile strength.

Each completed case is instrumented with strain ga during hydrostatic test to determine stresses at all criti areas—before shipment to Thiokol.

The firm is currently engaged in a cost reduction progr which includes new fabrication techniques.



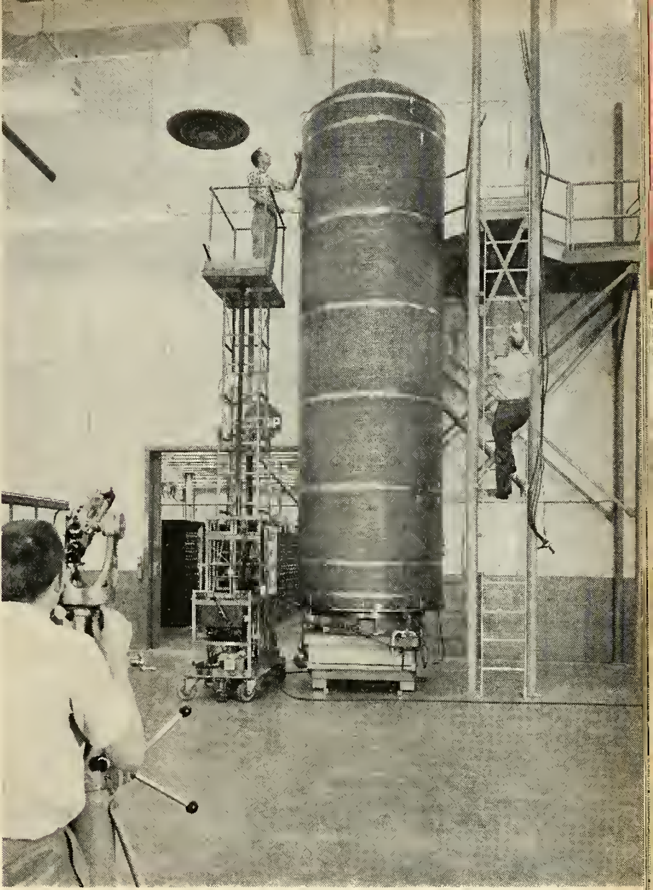
BOVE LEFT: *CYLINDRICAL SECTIONS are welded to-ther while rigidly fixed in position. Intermediate operations ch as weld grinding and inspections are also handled.*

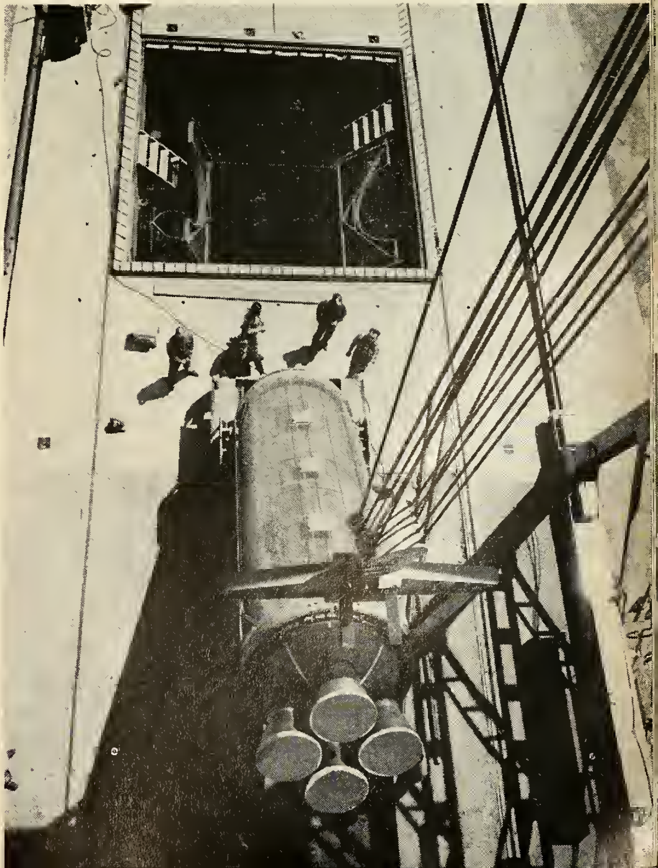
BOVE RIGHT: *INTERNAL BACK-UP FIXTURES brace the inders during the joining process. Close control is kept over welding variables of filler feed and power.*

LOW: *TEMPLATES AND TRACERS aid in the machining the closure dome. Reinforcement is provided at the nozzle apter junction by machining the outside of the closure.*

P RIGHT: *OPTICAL INSTRUMENTS are used to check dimensional inspections on a finished case. This chamber nds 22 ft. high and measures 65 in. in diameter.*

TTOM RIGHT: *LOADED FIRST-STAGE motor moves out a Thiokol casting pit. The engine is subjected to radiographic pection before being shipped to firing bay.*





ARS Meeting Hits Lack of Research

Record space power conference hears demands for more investment by industry if space materials are to be found

Santa Monica—The largest conference on space power systems ever held concluded here with agreement that the common denominator of all systems now under consideration is a lack of knowledge of materials. And the high temperatures at which most systems must operate are beyond the capability of materials now in use, especially for extended periods of time.

Dr. Abe Zarem, Chairman of the American Rocket Society's Power Systems Committee, and president of Electro-Optical Sysetms, Inc., criticized U.S. "earth-based industry" for delays in developing the lightweight power sources needed fro advanced space vehicles.

"There is a lack of patient dollars in industry," Zarem said, "and we seem to require a quick financial return on money invested before we're willing to conduct long-range basic research." He pointed out that the government's investment of "patient dollars" in support of research has made possible present advanced power systems.

"Materials research is one area which must be pushed with all possible speed," Zarem added, "and the biggest obstacle here is one of communication between parties concerned and the proper allocation of priorities."

"A vast intensification of research and development effort in the area of energy conversion and advanced power sources is essential, not only to the military posture of this country, but also to the peaceful needs of more efficiently utilizing the limited resources which we possess on earth," he stressed.

"The exotic power packages being researched today may produce a billion-dollar industry before 1975," he predicted.

• **Emphasis on research**—Technical sessions at the conference covered highly specialized fields in energy sources development, including therm
electricity, thermionics, photovolta
cells, e-chemical cells, dynamic engin
and plasma generators, systems for n
clear auxiliary power, and a session
applications, safety and advanced s
tems.

Approximately 75 papers were p
sented at the conference, on subje
ranging from the theoretical physics
solar cells to the safety aspects of
nuclear power package. Seven pap
were presented by North Americ
Aviation's Atomics International Di
sion on the SNAP programs, w
emphasis on SNAP II.

One of the more theoretical a
futuristic of the recent ARS meetin
the conference heard a number of
scriptions of current systems, but c
centrated on basic research proble
and findings.

The immediate future will see po
systems based on solar energy

BULK ORGANIC
NITRATES

- **PGN** ... polyglycidyl nitrate
- **TEGDN** ... triethylene glycol dinitrate
- **PeTriN** ... pentaerythritol trinitrate
- **TMETN** ... trimethylol ethane trinitrate
- **BGDN** ... butylene glycol dinitrate
- **DEGDN** ... diethylene glycol dinitrate

The above explosive and high-energy plasticizers for solid propellants are now available (in any quantity) from Propellex. In addition, Propellex manufactures solid propellants, both of the composite and double-base type. Among these is a new composite propellant that combines high energy with extremely low sensitivity to temperature changes.

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hotovoltaic converters only, according o N. W. Snyder, of the Institute for efense Analysis. "Power levels ex ected of the systems will immediately ictate two design requirements," he id, "these being the stabilization ethod and the array design."

• **100-watt dividing line**—Those ve icles requiring less than 100 watts ave been spin-stabilized, reducing com lexity of the stabilization subsystems. he increased number of solar cells re uired boosts both weight and cost of e array by a factor of four, Snyder id. *Pioneer, Explorer, Tiros, Transit,* nd *Courier* were designed in this anner.

Above 100 watts required power, ehicle stabilization is necessary, with tendant solar orientation of solar ar ay panels. Designed in this fashion e *Midas, Samos, Ranger* and *Advent.* he 100-watt power requirement is not n exact transition point from one esign to another, Snyder said, adding at the weight of non-working solar ells must be evaluated against the eight of the orientation subsystems.

• **Ranger system**—Power system for e *Ranger* spacecraft was described a paper by Jet Propulsion Laboratory ientists. Using oriented silicon photo ltaic cells, the *Ranger* is equipped ith an attitude control system to al w solar radiation to strike the cells rtically.

Primary silver-zinc batteries provide wer during launch phase, prior to n acquisition, and during guidance aneuvers when the solar power is adequate to power the craft.

The solar cells convert solar radia on—in the 0.4 to 1.4 micron wave ngth region—to electrical energy. ese cells are mounted in an alumi m honeycomb support structure fab ated from 0.0007-in.-thick foil and nded into a 3/8-in.-high honeycomb ucture by epoxy resin.

Sea-level earth efficiency of the cells about 12%. A six-mil-thick glass ver is epoxy bonded to the 1 x 2 cm lls to increase their emmissivity from 33 to 0.85.

• **Advent's power**—A similar de led breakdown was given by Richard . Karcher, of General Electric's Mis e and Space Vehicle Department, for *Advent.* The vehicle will be used a network of communication satel es in 24-hour orbits.

A constantly earth-oriented antenna ll be maintained by an attitude con l system. Power will come from otovoltaic cells distributed over one e of each of two paddles deployed opposite sides of the vehicle. Al ugh the paddles will be free to ate about one axis with respect to sun, the entire vehicle will be ped on each orbit to reorient the dles for the next pass. This is to avoid using slip rings in the assembly. The flip action will take place at high noon, and will involve a rotation about one axis only.

Energy storage during non-illuminated portions of the orbit will be accomplished with nickel-cadmium batteries. The chosen orbit, of a modified sinusoidal type, is expected to include a maximum darkened period of 75 minutes.

As in the *Ranger*, *Advent's* paddles are a series of laminations consisting of a honeycomb base, solar cells, bonding layer and glass cover. About 70 mils of fused silica are expected to be required to provide adequate mass for reducing ambient electron energy to 145 kev, the threshold of tolerance for silica cells.

Based on a 28-volt system, the arrays will contain about 70 cells in series, and the series strings then paralleled to produce the required power.

• **Versatile SNAP**—Uses of SNAP systems in space vehicles over the next 10 years were spelled out by Atomics International Div. of North American Aviation. J. R. Wetch and J. G. Lundholm estimate that the first use of the SNAP package will be with the *Atlas-Agena B* vehicle, and that it will also be used through the *Saturn* and *Nova* series of boosters.

When the performance of the SNAP packages was measured against various payload and propulsion parameters, it was concluded that any of the "workhorse" boosters expected to be in use over the next decade could easily boost a SNAP unit and a sizeable useful payload into various orbits and trajectories.

Electrical propulsion, coupled with a 3000-lb. SNAP system generating 70 kw, could place a useful payload of 1000 to 2000 lbs. into a 24-hour orbit after being boosted by an *Atlas-Centaur*, according to the authors, there after leaving the entire SNAP package free for wide-band communications work. The electric propulsion device could subsequently be used for orbit corrections.

Two project engineers from the Allison Division of General Motors presented a paper on Stirling cycle engines for space power, pointing out that the engine's characteristics are well suited to application where engine efficiency is a vital consideration in over-all system weight. They specified satellite solar power as a potential application.

M. D. Parker and C. L. Smith pointed out the moderate temperatures prevailing even at high efficiencies, and the operating environment in which the engine's moving parts operate, contributing to long life. They emphasized that no breakthroughs are required and that reliability is maximum.

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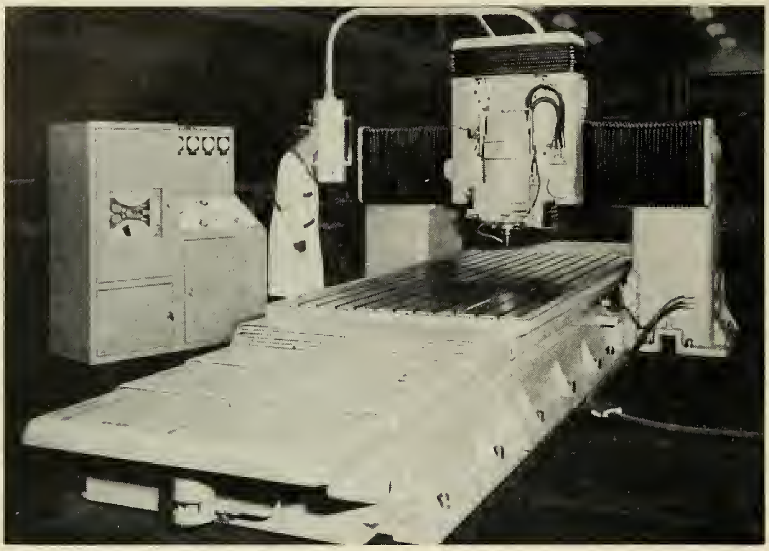


Tape Controlled Milling Machine

The No. 200 Series "ECCOMILL" Continuous Path, Tape Controlled Milling & Profiling Machines, have been developed by Ekstrom, Carlson & Co.

The series of the traveling table, vertical spindle, bridge-type design, covers a broad range of sizes with multiple axis control.

Among its features are anti-backlash, recirculating, ball-bearing precision screws on each axis and anti-friction, unit-type recirculating roller bearings on the table. The saddle and vertical slide operate on hardened and ground ways and the DC Milling Head provides continuously variable spindle speeds from 15 to 6000 RPM.

Circle No. 225 on Subscriber Service Card.

Submarine O_2 Valve

A differential pressure-regulating valve for submarine high-pressure electrolytic oxygen generating systems has been designed by The Garrett Corp.'s AiResearch Manufacturing Division.

The unit is installed in a by-pass line around a feedwater pump supplying distilled water to electrolytic cells. The valve can regulate 50 to 4000 psig inlet water pressure to the cells, maintaining a fixed differential of 50 ±5 psi above generated oxygen pressure sensed by a valve bellows assembly.

Circle No. 226 on Subscriber Service Card.

Quick Start 2-oz. Motor

A subminiature motor, measuring 1$\frac{7}{32}$ in. long and weighing only two ounces has been announced by The A. W. Haydon Co.

Featuring almost instantaneous starting and stopping characteristics, this unidirectional or reversible 400-cycle a. c. timing motor, designated as the 25100 series, incorporates a phase-shift network providing one winding ninety degrees out of phase to assure rapid starting, smooth operation, and ease of reversal.

Circle No. 227 on Subscriber Service Card.

Fibrous Titanate

"Tipersul," fibrous potassium titanate, a new crystalline fiber material for high-temperature applications, is available from E. I. DuPont de Nemours & Co.

The small, white crystalline fibers useful to 2200°F are available in lumps and loose fibers, as well as blocks, sheets and paper forms made by standard felting techniques. Curbed or odd shapes are also available.

Circle No. 228 on Subscriber Service Card.

Environmental Refrigerant

Isotron 13 for low-temperature environmental refrigeration applications is being produced by Pennsalt Chemicals Corp.

Isotron 13 (monochlorotrifluoromethane) can be used to produc temperatures below –100°F. It will b particularly useful in low-temperatur research and testing where exceptionall low environmental temperatures ar desired.

Circle No. 229 on Subscriber Service Card.

Center of Gravity Locater

An aid for the Vibration Test Laboratories, which can reduce set-up tim as much as 90%, is being markete under the name of "Cee-Gee Locator, by Auto-Control Labs. Inc. The instrument quickly and accurately position the center of gravity of test specime and fixture axially along the center o force of the vibration exciter within l gram-inches.

Circle No. 230 on Subscriber Service Card.

High Temperature Sensors

Aero Research Instrument Co. ha developed a complete line of thermo couple-type temperature sensors for us up to 4000°F.

The devices, of both non-cooled an cooled types, measure liquid, solid an gaseous temperatures. Some of th sensors are usable in oxidizing atmosphere up to 4000°F and intermittentl higher.

These probes are designed for suc typical applications as measuring th temperaures of exhaust gas in an afte burner, molten glass, fuel pins in nuclear reactor, missile nose cones ar combustion processes.

Circle No. 231 on Subscriber Service Card.

Cryogenic Ball Valve

Built to handle liquid oxygen in missile fueling system, a KOEHLER Dayton ball valve from Koehler Ai craft Products Co. weighs appro mately 1100 lbs.

Valve body and full ball closu are of stainless steel; through prop choice of seal materials the unit m be quickly adapted to handle a wi

ariety of liquids such as water alcohol ixtures, liquid nitrogen, natural or nthetic lube fluids, hydraulic fluids, d most fuels.

The valve actuator uses gaseous itrogen as the operating medium and cludes hermetically sealed limit vitches to provide remote (electrical) dication of valve position.

Circle No. 232 on Subscriber Service Card.

hree-in-one Amplifier

A Model 1100 amplifier now availble from Cubic Corp. combines in one ckage the features of three individual its: a differential-input wideband DC nplifier, a bridge balance circuit, and well regulated strain-gauge power pply.

In instrumentation applications here a self-contained power supply is t essential, two DC amplifiers can be mbined in a single unit, boosting fm 8 to 16 the number of amplifiers tat can be mounted abreast in a sndard 19-in. rack.

Circle No. 233 on Subscriber Service Card.

ny Servo Gearhead

A high-precision miniature servo grhead has recently been added to t line of gearheads made by Exact Egineering and Manufacturing Co.

Almost one thousand different ratios a available from 3.08:1 to 16,384:1 i Model E11. These ratios are obtned by using from two to seven gear sges, and a motor output pinion with eher 10, 12, 13, or 15 teeth.

Circle No. 234 on Subscriber Service Card.

Bryllium Monitor

In conjunction with the U.K.A.E.A.. Pssey Nucleonics Ltd. have produced a portable radiation monitor, designed f comfortable transportation by two n, capable of detecting beryllium in a aggregate containing less than 0 1% BeO.

Transistorised, shockproof and impvious to extremes of temperature a humidity, the equipment is powered by eight U2 type dry cells stored in the monitor. The sensitivity is such that 0.004% BeO doubles the normal background rate.

Circle No. 235 on Subscriber Service Card.

Sealed Rotary Switch

An RSA Rotary Switch has been introduced by the Denver Division of Hathaway Instruments, Inc.

The magnetically operated, hermetically sealed contacts are rated at 10 million operations each at 100 ma current. They are gold-plated for low contact resistance and sealed in nitrogen for insurance against corrosion. The contacts will interrupt up to 500 ma, 115v AC with a decrease in rated life. Each contact is double-ended so that circuits requiring isolated contacts in a rotary switch configuration now become feasible.

Circle No. 236 on Subscriber Service Card.

Ferrite Materials

Two recently developed ferromagnetic materials, completing a series of magnesium-manganese-aluminum ferrites, are now available to designers of isolators, circulators, duplexers and other microwave devices, from Motorola Inc., Military Electronics Division.

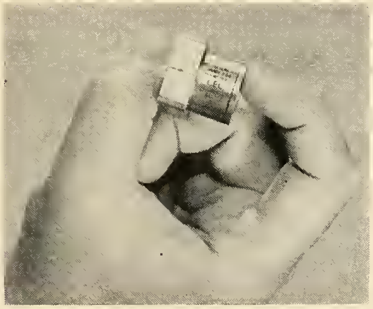
Types M-092 and M-112 microwave ferrites, complete a family of four ferrite materials designed for general nonreciprocal device applications.

Circle No. 237 on Subscriber Service Card.

Miniature Strain Gage

The smallest temperature-compensated strain gage accelerometer available has been developed by the Transducer Division of Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell Co.

The Type 4-202 is a linear, unbonded, strain-gage bi-directional instrument, designed for measuring accelerations perpendicular to the mounting surface. Weighing less than 3 oz., the 1-cu.-in. accelerometer's linearity and hysteresis qualities are conservatively rated at less than ±0.75% of full-range output.



Circle No. 238 on Subscriber Service Card.

new literature

INSTRUMENT CATALOG—Statham Instruments, Inc., has published a 32-page General Catalog with concise descriptions of Statham pressure transducers, linear and angular accelerometers, load cells, amplifiers, power supplies, bridge balances, strain gages and force/displacement transducers.

Circle No. 200 on Subscriber Service Card.

TAPE ANALYZER—A four-page bulletin on the Automatic Tape Analyzer is available from Graver Water Conditioning Co., a division of Union Tank Car Co. The bulletin, WC-127, covers all facets of the unit, including method and principle of operation, potential applications and basic specifications for the instrument, and the Milipore Filter (R) tape used as the testing medium. It also gives design data, including components and materials of construction.

Circle No. 201 on Subscriber Service Card.

LOAD CELL STANDARDS—An eight-page Technical Bulletin TD-103 on precision high-capacity force standards has just been released by Gilmore Industries, Inc. The bulletin discusses the various types of secondary standards available for force measurement, as well as the reasons why the confidence factor decreases as the secondary standard accuracy approaches the accuracy of the primary standard.

Circle No. 202 on Subscriber Service Card.

WINCHES AND HOISTS—Breeze Corporations, Inc. has released a catalog file covering its line of winches and hoists. All pertinent data and drawings are shown for rescue hoists, heavy duty cargo hoists, hook drives, hand-operated hoists, combination winches and hoists and various hooks and accessories including a remote release cargo hook.

Circle No. 203 on Subscriber Service Card.

MISSILE TRAINING AID GUIDE—"A Guide To The Selection of Panel Type Training Tools" has been made available by Burton-Rodgers, Inc. The book establishes procedures to use in determining the type of missile trainer required for specific applications. Over 20 photographs and many charts aid the training coordinator.

Circle No. 204 on Subscriber Service Card.

LANGUAGE LABORATORY — A brochure outlining a new concept in language laboratory components has been published by Switchcraft, Inc. The components offer a convenient, simplified, portable and low-cost language laboratory set-up.

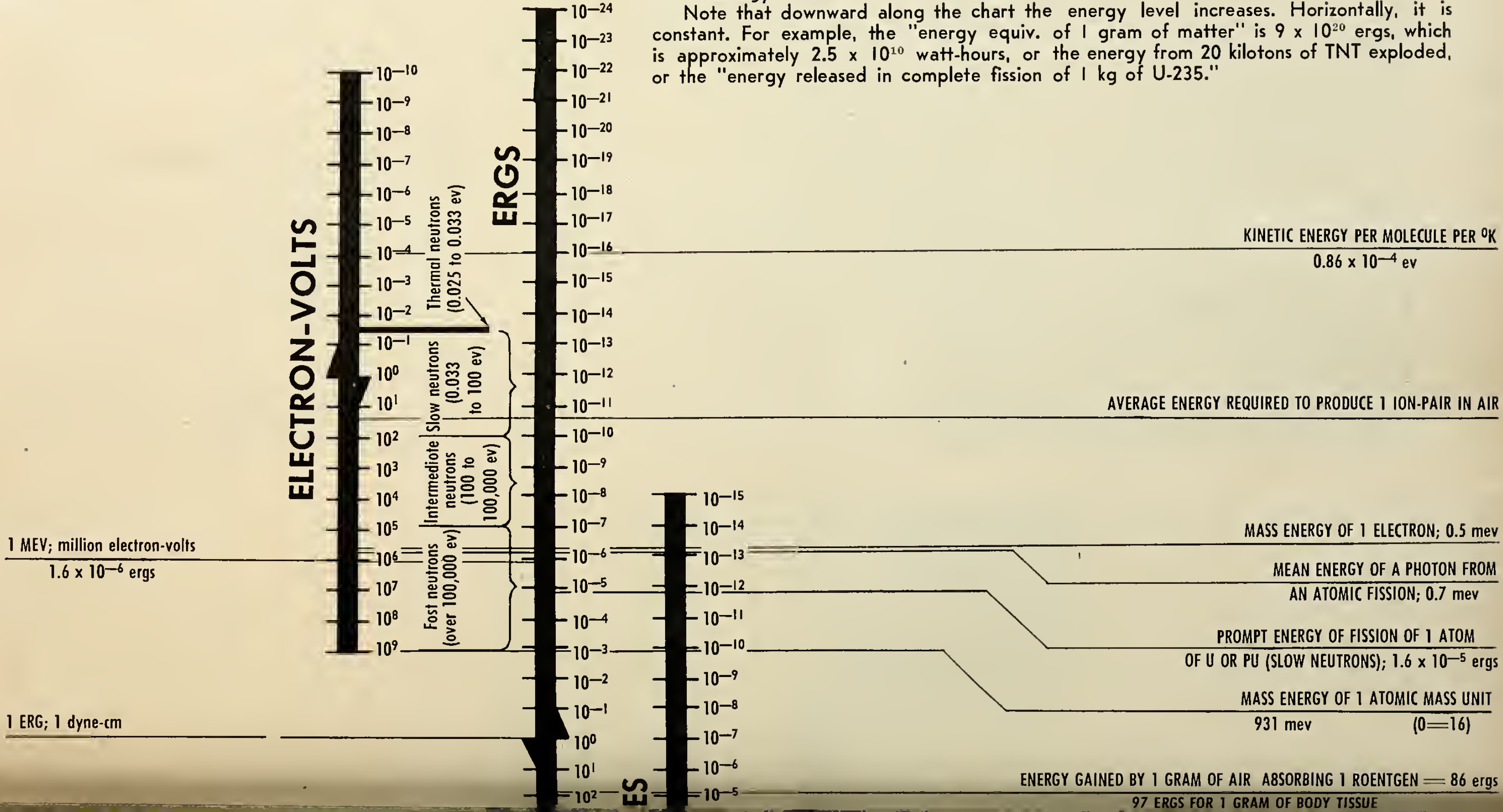
Circle No. 205 on Subscriber Service Card.

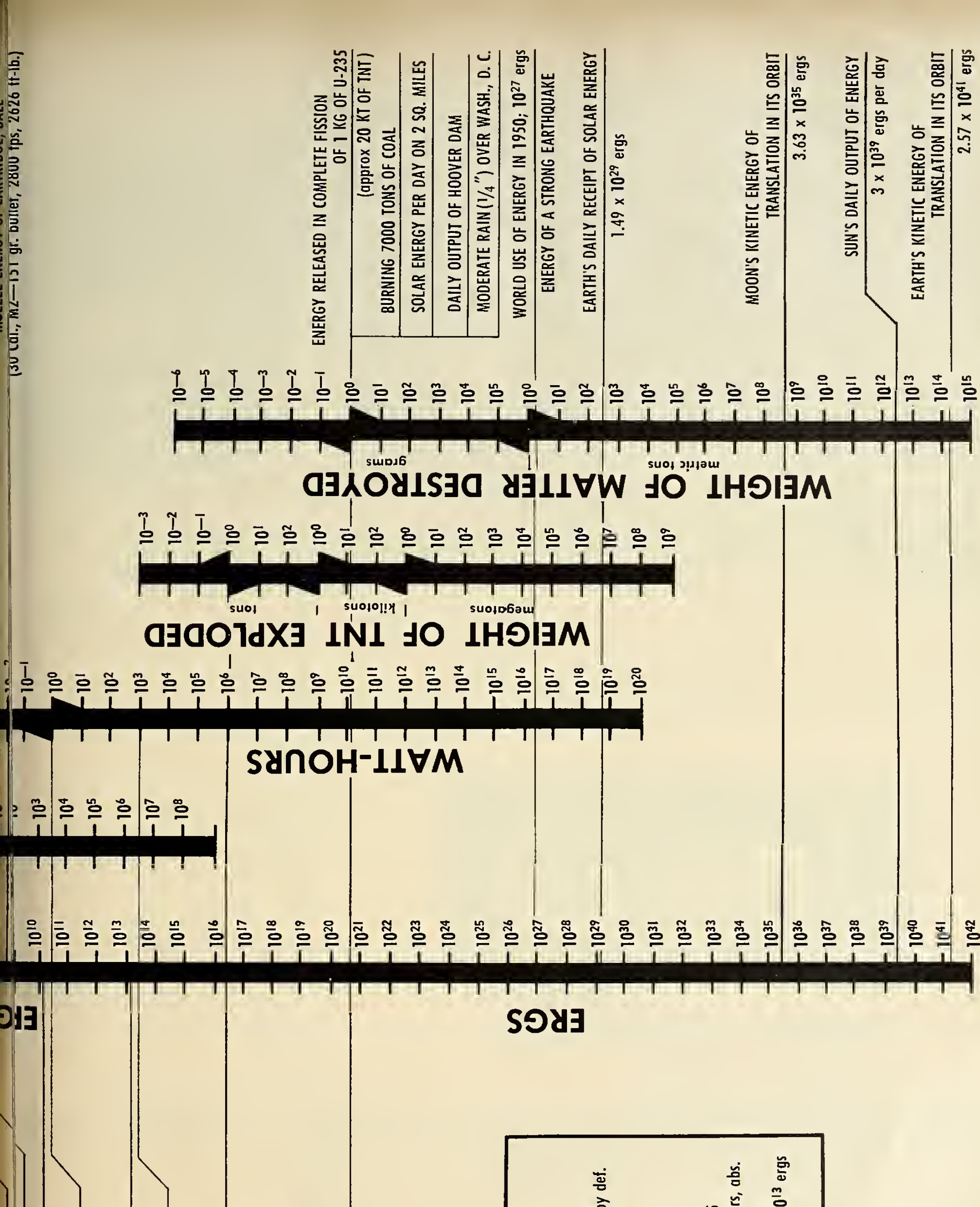
THE ENERGY LEVEL OF THINGS

J. R. Williams
Air Force Special Weapons Center (ARDC)
Kirtland Air Force Base, New Mexico

OFTEN THE ENERGY UNITS used in one scientific field are not easily put into perspective by workers in another field. Thus, while certain units are utterly familiar to particular specialists, other units seem to exist only to confound. This chart has been designed to relate several commonly used units and to give "real life" benchmarks to a few of the energy levels.

Note that downward along the chart the energy level increases. Horizontally, it is constant. For example, the "energy equiv. of I gram of matter" is 9 x 10^{20} ergs, which is approximately 2.5 x 10^{10} watt-hours, or the energy from 20 kilotons of TNT exploded, or the "energy released in complete fission of I kg of U-235."





NOTES

[1] 1 I T calorie = 1/860 international watt-hour, by def.

[2] BTU = 251.996 I T calories, by def.

[3] 1 watt-hour, international = 1.000165 watt-hours, abs.

[4] metric horsepower-hour = 2.648×10^{13} ergs

contracts

NASA

Horkey-Moore Associates, a division of **Houston Fearless Corp.,** Torrance, Calif., for design and fabrication of a systems test fixture for ground checkout of the *Ranger* spacecraft. Amount not disclosed.

$2,771,720—**Hayes Aircraft Corp.,** Birmingham, Ala., for fabrication of ground support equipment for the *Saturn* launch complex at Cape Canaveral. (Augments a $4,241,400 contract let Aug. 1 to Hayes.)

NAVY

$3,543,019—**Remington Rand Univac Military Div.,** St. Paul, for research and development leading to an advanced computer and hardware ($1,924,019) and continued development of an electronic data processing system and related equipment ($1,619,000).

$2,000,000—**General Electric Co.,** for production of fire control directors for the *Tartar* weapon system.

$1,100,000—**Sanders Associates, Inc.,** Nashua, N.H., for the *Eagle* missile seeker system development program. Subcontract from **Bendix Corp.**

$947,000—**Westinghouse Electric Corp.'s Electronic Tube Div.,** Pittsburgh, for specialized microwave tubes to be used in the new *Typhon* weapon system. Subcontract.

$500,000—**The American Optical Co.,** Southbridge, Mass., for production of Mark 13 target detecting devices used on the *Sidewinder 1-C* missile.

AIR FORCE

Northrop Corp. was awarded a multimillion-dollar subcontract from **The Martin Co.** for *Titan* base activation at Ellsworth AFB, S.D. Amount not disclosed.

$17,000,000—**Thiokol Chemical Corp.,** Bristol, Pa., for continuation of work on the *Minuteman* first-stage solid-propellant engine.

$7,500,000—**Sylvania Electric Products Inc.,** Buffalo, for development and engineering of the command communication subsystem of the radio launch control system for the *Minuteman.* Subcontract from **Boeing Airplane Co.'s Aero-Space Div.**

$6,000,000—**Douglas Aircraft Co.,** Santa Monica, for components, spare parts, engineering and technical data for the *MB-1 Genie* rocket.

$2,000,000—**Lear, Inc.,** Santa Monica, for the north-seeking gyro in connection with the *Minuteman.* Subcontract from **North American Aviation,** prime contract for the guidance system.

$1,500,000—**Pacific Automation Products, Inc.,** Glendale, Calif., for procurement of custom cabling to be used in the *Atlas* silo bases. Subcontract from **Convair Astronautics.**

$1,000,000—**Space Technology Laboratories,** Los Angeles, for *Project Advent,* a communications satellite.

$1,000,000—**Leach Corp.'s Relay Div.,** Los Angeles, for relays for the tactical launch control equipment of the *Atlas* series "E" missile. Subcontract from **Hallamore Electronics.**

$1,000,000—**General Electric's Rocket Engin Section,** Cincinnati, for research and development of the company's plug nozzl rocket engine concept.

$730,945—**The M&T Co.,** Philadelphia, fo non-personal services for on-site operation, maintenance and supply suppor for SAGE utility systems. (Two contracts).

$500,000—**Electradata Corp.'s Airite Div.,** Lo Angeles, for production of titanium vessels for the *Titan.* Subcontract fror **The Martin Co.,** Denver.

$421,180—**John E. Fast & Co.,** Chicago, fo capacitors to be used in guidance an control systems of the *Minuteman.* Subcontract from **North American Aviatio Inc.'s Autonetics Div.**

$52,990—**National Research Corp.,** Cambridg Mass., for one year's study, constructio and experimentation on photoemissiv devices which convert the sun's energ to electric power.

ARMY

The Budd Co., Philadelphia, for develo ment of high-performance solid-prope lant rocket motor cases. Amount n disclosed.

North American Aviation, Inc., has awarde its **Rocketdyne Div.** a contract for lin ited production of solid-propella boosters to be used in fabrication ar flight testing of *Redhead-Roadrunner,* new target missile system. Amount n disclosed.

$2,600,000—**Hazeltine Corp.,** for 37 new tran portable 40-ft. radar antennas.

$2,000,000—**Goodyear Aircraft Corp.,** Akro for additional work on the *Nike-Zeus.*

$1,500,000—**Western Electric Co.,** New Yo, City, for further work on the *Nike-Ze* system.

$417,000—**The Marquardt Corp.'s Cooper D velopment Div.,** Monrovia, Calif., for pr duction of 600 meteorological rock systems.

$409,841—**International Builders of Florid Inc.,** Coral Gables, for construction buildings to be used in support of t *Polaris* program.

MISCELLANEOUS

General Vacuum Corp., E. Boston, Mas for design and construction of a ne large-scale vacuum facility. Awarded **General Electric's Research Laborator**

$2,500,000—**Fruehauf Trailer Co.'s Milita Equipment and Missile Products Di** Detroit, for manufacture of various typ of ground support equipment.

review

OPTICAL INDUSTRY DIRECTORY, 19 issue. The Optical Publishing Co. Len Mass. $7.50.

About four hundred instruments, co ponents, raw materials, and services i portant to the optics industry are list Current information concerning 12 American company sources capable furnishing these items and a compl catalog of all corrected lenses, both mestic and foreign, are included.

The scope of the Directory has be considerably expanded over previ issues. Photographic, photoelectric, a infrared devices and advances in the strumentation of space technology ceive more detailed coverage.

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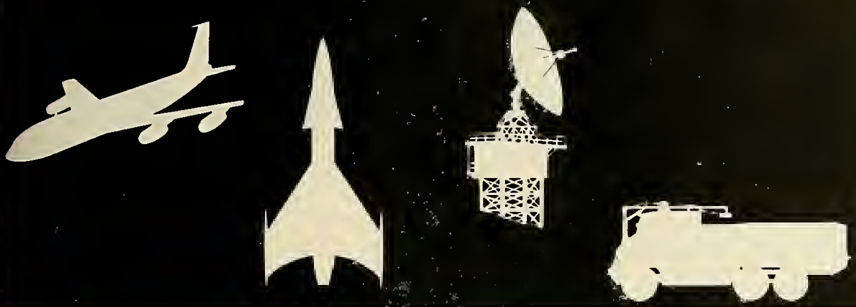

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names in the news

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Richard H. Horton: Joins National Research Associates, Inc. as director of Plans and Marketing. Was previously supervisor of powerplant design at General Electric's Large Jet Engine Division.

Lt. Gen. C. S. (Bill) Irvine (USAF-ret.): Elected to the board of directors of Idaho Maryland Industries, Inc. He is also vice president and director of planning of Avco Corp. and a director of Houston Fearless Corp.

Harvey A. Druker and **Victor Schwab:** Join Navigation Computer Corp. as application engineers. Druker was formerly project engineer on digital systems with Briggs Associates, Inc.; Schwab was a digital design engineer with Remington Rand Univac.

Dr. Charles E. Crompton: Named director of the Advanced Development Section in the Isotopic Power Department of The Martin Co.'s Nuclear Division, concerned with advanced applications of radioisotopes as a source of heat and electricity.

Myron D. Lockwood: Elected vice president of Sperry Gyroscope Co. He joined the firm in 1945 as a project engineer and has been manager of the Surface Armament Division since 1957.

Robert G. Nunn, Jr.: Former assistant general counsel at NASA, appointed special assistant to NASA administrator **T. Keith Glennan.**

Dr. John H. Pearson: Appointed director of advance research planning for Allied Chemical's General Chemical Division.

Herbert L. Karsch: Former manager of Aerospace operations for General Motors Corp.'s Defense Systems Division, joins Ford Motor Co.'s Aeronutronic Division as manager of Space Technology Operations' Space Systems. He succeeds **Ralph P. Morgan,** named special assistant to **Dr. Donal B. Duncan,** general operations manager.

Lt. Gen. Charles B. Stone, III (USAF-ret.): Appointed a vice president of American Brake Shoe Co. and a group executive for the companies newly-formed Hydraulics Group. He will have overall responsibility for two divisions, Denison Engineering and Kellogg, and two subsidiaries, Raymond Atchley, Inc., and Hydel, Inc.

C. Edward Bold: Named manager-marketing operation for the General Electric Co.'s Special Programs Section. Was formerly manager-sales for the defense system-oriented section.

Stuart E. Weaver and **Harry B. Horne:** Elected vice presidents of The Marquardt Corp. Weaver, former vice-president, engineering, for Northrop Corp.'s Radioplane Div., will be in charge of marketing research; Horne will continue as director of corporate planning.

Thomas H. Mansfield: Former manager of Hughes Aircraft Co.'s Guidance and Controls Dept., appointed chief engineer at Servomechanisms/Inc.

Henry S. Loeber: Named sales manager to direct the marketing of Chester Cable Corp.'s products.

Milton Jennis: Formerly manager of manufacturing engineering of W. L. Maxson Corp., joins the Cross-Malaker Laboratories of Mountainside, N.J., as projects director.

Robert V. Schmidt: Former vice president of United Research Inc., appointed chief of Research Marketing for Northrop Corp.'s Norair Division.

Dr. Conrad L. Longmire: Former alternate division leader of the Theoretical Division of the Atomic Energy Commission's Los Alamos Scientific Laboratory, joins the staff of the Avco-Everett Research Laboratory. He will be engaged in research pertaining to ballistic missile defense.

Irwin Klugler: Joins Computer Systems, Information Technology Division of Lockheed Electronics Co. as a senior mathematician assigned to the Mathematical Analysis Dept. Was formerly with Technical Operations, Inc. involved in work on Project *Omega.*

Frank W. Lehan: Space Electroni
Corp. received the annual IRE Profe
sional Group on Space Electronics an
Telemetry award in recognition of h
"valuable contributions to space ele
tronics and telemetry." The award, base
on Lehan's work in phase-locked loo
receivers and narrow-band informatio
transmission systems, was made at rece
PGSET Symposium.

Walter W. Kunde, Jr.: Former direct
of engineering for Communication Acce
sories Co., named chief engineer
Hermetic Seal Transformer Co.'s Tex
Components Division.

Edward J. Verity: Appointed manag
of the marketing research department
Garlock, Inc. Was formerly vice preside
and general manager of Clayton Skif
Inc., Toms River plant.

John K. Rondou: Former vice pres
dent and general manager named pres
dent and general manager of Comput
Measurements Co., a division of Pacif
Industries.

Earl J. Handly: Promoted to the newl
created post of division planning manag
for Raytheon Co.'s Industrial Componen
Division. Was formerly market plannir
manager for the division.

Norman Burstein: Former sales ma
ager of Temperature Engineering Cor
elected vice president-marketing.

Dr. Charles R. Kelly: Member of t
professional staff of Dunlap and Ass
ciates, Inc., appointed director of t
corporation's experimental laboratory.

Gifford K. Johnson: Appointed exec
tive vice president of Chance Vought Ai
craft Inc. He has been with the compa
for the past 10 years and was a key ma
in the firm's recent diversification activ
ties.

Jack H. Zillman: Elected vice pres
dent of Consolidated Electrodynami
Corp.'s data proccssing divisions, r
sponsible for operations of Consolidated
Datalab, DataTape, Transducer and Ele
tro Mechanical Instruments. Was pr
viously vice president and general ma
ager of Daystrom, Inc.'s Pacific Divisio

—when and where

OCTOBER

Sth National Seminar of American Society for Industrial Security, Statler Hilton Hotel, Dallas, Oct. 3-5.

stitute of Radio Engineers, Professional Group on Communications Systems, Sixth National Communications Symposium, Utica, N.Y., Oct. 3-5.

IE Annual Meeting of the Professional Group on Nuclear Science, "Solid State Radiation Detectors," co-sponsored by Oak Ridge National Lab., Gatlinburg, Tenn., Oct. 3-5.

Sth Conference on Radio Interference Reduction, Sponsors: Armour Research Foundation, U.S. Army, U.S. Navy, USAF, IRE Professional Group on Radio Frequency Interference, Chicago, Oct. 4-6.

Befing Session on Opportunities in Space-Age Technology, American Management Association, Hotel Astor, New York City, Oct. 5-7.

Aerican Ceramic Society, Refractories Division, Bedford Springs Hotel, Bedford, Pa., Oct. 6-8.

Btish Institution of Radio Engineers, SW Section, Aviation Electronics and Its Industrial Applications, Bristol College of Science and Technology, Oct. 7-8.

AME Rubber and Plastics Conference, Lawrence Hotel, Erie, Pa., Oct. 9-12.

Ntional Electronics Conference and Exhibition, Hotel Sherman, Chicago, Oct. 10-12.

AS Human Factors and Bioastronautics Conference, Biltmore Hotel, Dayton, Ohio, Oct. 10-12.

Siety of Automotive Engineers, National Aeronautic Meeting, Ambassador Hotel, Los Angeles, Oct. 10-14.

IE/ASQC Reliability Training Conference, Southwest Area, Lake Texoma Lodge, Kingston, Okla., Oct. 10-15.

Aerican Vacuum Society, Seventh National Symposium, Cleveland-Sheraton Hotel, Cleveland, Oct. 12-14.

Aerican Ceramic Society, Glass Division, Bedford Springs Hotel, Bedford, Pa., Oct. 12-14.

Aerican Society for Quality Control, 15th Midwest Conference, Broadview Hotel, Wichita, Kan., Oct. 14-15.

Sciety for Photographic Scientists and Engineers, Revolution in High-Speed Processing, Oct. 14-15.

AME-ASLE Lubrication Conference, Statler-Hilton Hotel, Boston, Oct. 17-19.

Jot Meeting, Institute of the Aeroautical Sciences and Canadian Aeroautical Institute, Queen Elizabeth Hotel, Montreal, Oct. 17-18.

42nd National Metal Exposition and Congress, Trade and Convention Center, Philadelphia, Oct. 17-21.

American Ceramic Society, 13th Pacific Coast Regional Meeting, Ambassador Hotel, Los Angeles, Oct. 18-21.

Conference on Hypervelocity Projection Techniques, University of Denver, Institute of the Aeronautical Sciences, Denver, Oct. 20-21.

ASME-American Society of Mining, Metallurgical and Petroleum Engineers, Fuels Conference, Daniel Boone Hotel, Charleston, W.Va., Oct. 24-25.

Medical and Biological Aspects of the Energies of Space Symposium, sponsored by USAF Aerospace Medical Center, (ATC) Granada Hotel, San Antonio, Tex. Oct. 24-26.

Sixth Annual IRE Electron Devices Meeting, Shoreham Hotel, Washington, D.C., Oct. 26-27.

NOVEMBER

First National Die Casting Exposition and Congress, Detroit Artillery Armory, Detroit, Nov. 8-11.

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, JULY 2, 1946 AND JUNE 11, 1960 (74 STAT. 208) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF

MISSILES AND ROCKETS, published every Monday with the exception of the last Monday in December at Harrisburg, Pennsylvania, for October 3, 1959.

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5. The average number of copies of each issue of this publication sold or distributed through the mails or otherwise to paid subscribers during the 12 months preceding the date shown above was: 28,833.

LEONARD A. EISERER,
(Signature of business manager)

Sworn to and subscribed before me this 22nd, day of September 1960.

RETTA B. LUDDEKE,
Notary Public.
(My commission expires Nov. 14, 1962)

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editorial . . .

The Issue of Space and Defense:

How Long Must It Be Ignored?

THE OPEN LETTER on Page 10 of this issue asks that both candidates for President bring the space/defense issue out into the open; that they make known their views clearly and unequivocally.

The hour grows late. We strongly suggest that the second televised debate on October 7 is not too soon to start.

When the President made his speech at what has been called the "rump summit" at the United Nations last week, he must have been acutely conscious of his nation's weakness in defense and space exploration—two vital areas where Russia is strong.

This may explain why at certain points he was weak where he could have been strong and indecisive where he could have been sure.

Were he secure in our military strength and certain of its superiority, Mr. Eisenhower might have felt unembarrassed in leaving an opening for a reconciliation with the leader of the Soviets.

Were we not all wondering at just what moment the Russians will announce their next spectacular space triumph, he might have been more realistic in his proposals governing space.

The truth is that we are not strong enough in either area—defense or space conquest—to be forthright.

What is equally important, neither candidate seeking to be the next President has made these subjects an issue for the campaign and neither has clearly set forth his stand on them nor seems inclined to.

Mr. Kennedy has remarked vaguely that we must spend more money to build up our defenses.

Mr. Nixon seems to feel that if he doesn't mention the problem it will go away.

In his remarks at the U. N., Mr. Eisenhower made four proposals for space: that there should be no territorial claims to celestial bodies; no warlike activities on these bodies; that there should be no weapons of mass destruction permitted in space; that the U. N. should verify in advance all launchings.

The daily press referred to his remarks as declaring space "off limits" to the military. The effects of that are already apparent. Certain officials at NASA are now wary of admitting that they participate in explorations carried out by the military, fearful of Administration displeasure.

The truth is that just as missiles have become synonomous with defense, so has defense become forever linked with space.

Space has a strategic value beyond our present comprehension. Every indication points to the fact that the Russians understand this only too well. They are not concerned with weather forecasting, with reconnaissance (which they don't need) or with communications. They are concerned with getting man into space, man on the moon. These achievements have strategic value.

Our national goal has been "space for peaceful purposes."

We suggest that "freedom of space" would be a better goal.

Freedom of Space, like freedom of the seas, denotes regulation, security and equality of usage.

"Peaceful purpose" could mean what Khrushchev defines it to mean if his nation gets there first with enough strength to keep others out.

The world didn't get freedom of the seas by wishful thinking and we won't get freedom of space that way either. We'll get it by being strong enough to defend freedom there.

IF THIS DEFENSE of the freedom of space can be under the aegis of the United Nations, as it should be, that is fine. But who will provide the United Nations with the weapons and the space force necessary to do the policing? The Russians? Perish the thought.

This issue of defense and space is not remote and it should not be dealt with vaguely. It is an immediate problem. It may soon be a matter of survival.

Clarke Newlon

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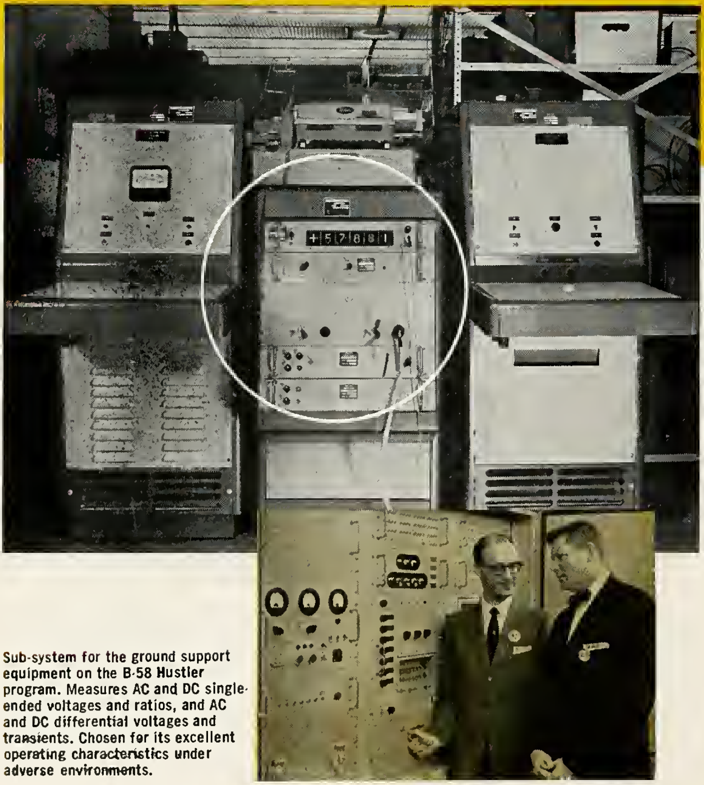

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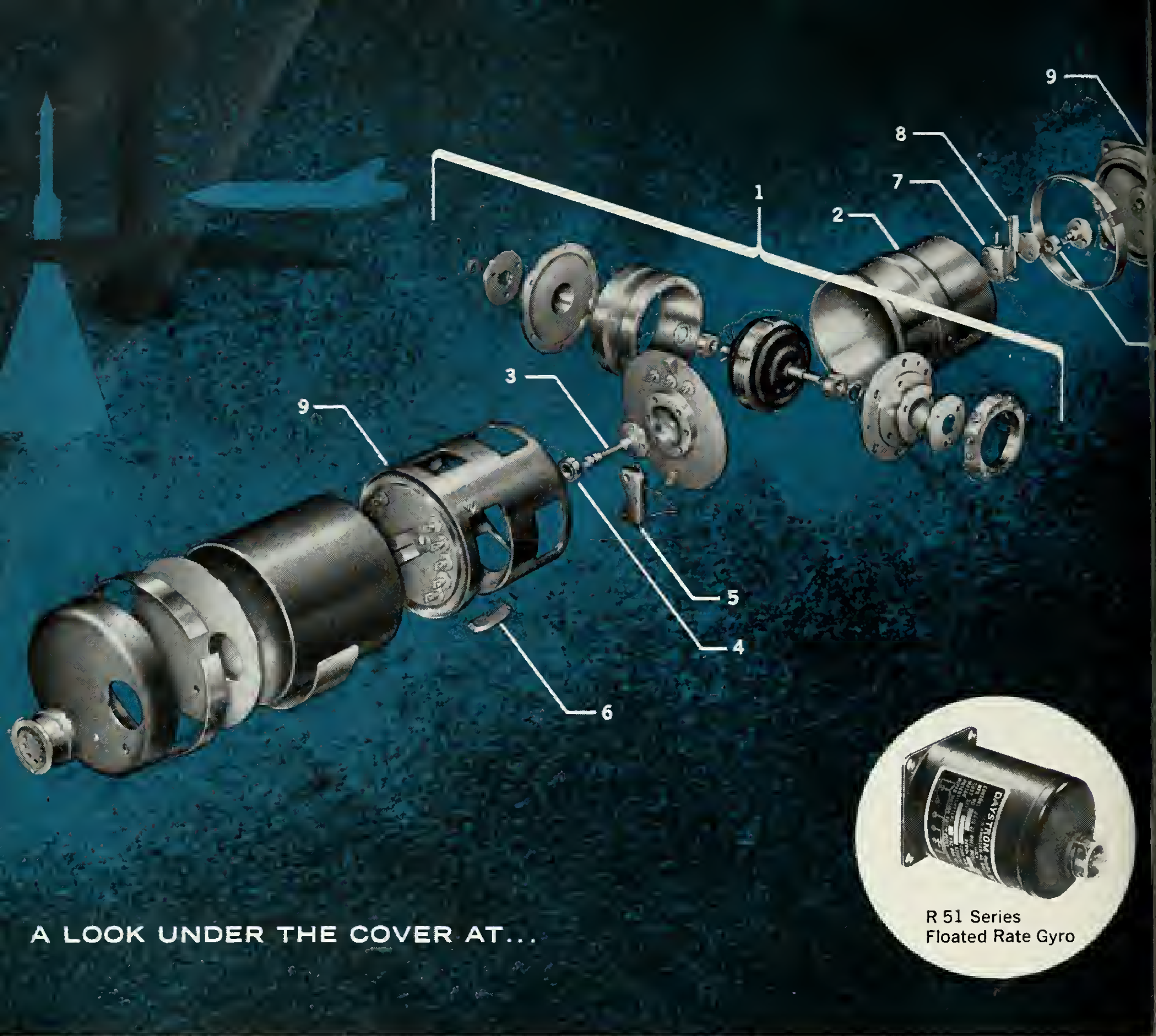

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THE COVER

Lt. Gen. Arthur G. Trudeau, Army R&D boss, says his service is the only logical developer of a land-based, 1000-mile-range tactical missile. See interview on p. 16.

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The Countdown

WASHINGTON

Way to Speed Dyna-Soar?

COUNTDOWN understands there is some high-level sentiment in DOD to drop the weapon system requirement on *Dyna-Soar*—in order to speed its development. Some experts believe the present concept for the space vehicle should be a stepping-stone to a weapon, not an end product. If it were handled strictly as an R&D venture, then a lot of the "garbage" (redundancy, "idiot-proofing," etc.) could be eliminated initially. The hitch, however, is that the Air Force under Administration policy must now justify *Dyna-Soar* as a weapon, to get the necessary funding. If it drops this requirement, the wolves will move in.

Shell Game

Latest shift in Navy budget planning for FY '62 is understood to entail dropping a request for another aircraft carrier and applying the money to a school of nuclear-powered attack submarines. These subs are needed to protect *Polaris* subs.

Deployment Delay

Instead of getting the first *Polaris* sub—the George Washington—out on station late this month as hoped, the Navy now says it will be early in November. The delay amounts to about two weeks. And, COUNTDOWN is told it is attributable largely to the IAM strike earlier this year and last-minute equipment checkout.

Eagle vs. Typhon

A hot new rivalry in R&D may break out soon between the Navy's Bendix *Eagle* and its Westinghouse *Typhon*. The *Typhon* is a surface-to-air antimissile missile. *Eagle* is an air-to-air antiaircraft missile. But some advocates are reported to be claiming that *Eagle* also will have an antimissile capability.

NASA Visits SAC

A team of NASA scientists headed by Administrator T. Keith Glennan has given a briefing on their long-range plans to SAC. The group journeyed to Omaha at SAC Commander Thomas S. Power's request. Chief Topic: what the civilian agency believes it will be providing in technical capability and space hardware in the '60s.

On the Pad

First *Mercury-Redstone* may go this week from the Cape . . . *Tiros II* is scheduled tentatively for the week of Oct. 31 . . . Deadline for setting up another *Atlas-Able* has passed to make it possible for a pre-election moon shot.

Century Mark

Orbiting of the *Courier* communications satellite Oct. 4 (the third anniversary of *Sputnik*) was accomplished with the 100th launch of a Douglas *Thor*. Since its first shot Jan. 25, 1957, the *Thor* has been fired 63 times as an IRBM and 37 times in space experiments. The record: as an IRBM 10 shots were unsuccessful, 11 partially successful and 42 successful; as a space booster 4 shots were unsuccessful, 2 partially successful and the remaining 31 successful.

INDUSTRY

Five Were Quick

Only five out of 50 firms met the two-week deadline Aug. 26 for proposals on the *Minuteman* environmental control system. Winner is expected to get contract award within two weeks.

Front Office

In a top management shakeup, J. H. Carmichael has resigned as president of Fairchild Engine & Airplane Co. Founder Sherman M. Fairchild is stepping back in as acting chief executive officer. Carmichael's resignation came as the company reported losses of $587,000 for the first six months of the year.

At NASA

Bids are being asked by Oct. 30 at NASA's Marshall-Huntsville center on 42 aluminum LOX and RP tanks for *Saturn* Boosters 6 through 10 . . . There are only eight companies in competition for the Orbiting Geophysical Observatory satellite (Aerojet, Bendix, Convair, G-E, Grumman, Lockheed, RCA and STL) . . . At Huntsville a struggle is brewing between NASA and JPL facilities for jurisdiction over spacecraft guidance systems.

More Zeus Money

The Army is pumping more money into the *Nike-Zeus*. It has added $199 million to the development program in contracts awarded to Western Electric.

INTERNATIONAL

Australian CM Nose Cone

Australian scientist Dr. B. S. Thornton is offering the U.S. a new type of missile counter-measure nose cone. Special skin structure contains an electronic device to beam a false trajectory at enemy radar.

U.K. Midas Station

Ground surveys are under way in Britain for the siting of a ground station for U.S. *Midas IR* surveillance satellites. Preferred site is believed to be at Kirkbride, on the west coast of Scotland.

Rocket Tracker

EMI Electronics Ltd. has contracts with the British War Office and Swedish Army for a new radar tracker and trajectory calculator. The device is effective against mortar bombs and anti-tank rockets.

Overseas Pipeline

British Oxygen is ready to finance plant expansion with a $34 million stock issue . . . French Socialists are opposing De Gaulle's plan for creating a deterrent force . . . a German magazine quotes Dr. Wernher von Braun as saying he expects to be among the first passengers on a flight to the moon.

Engineering notes from the **SM/I REPORTER**

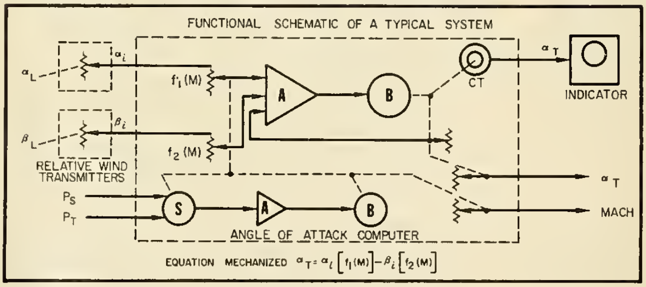
BY STANLEY M. INGERSOLL, *Capabilities Engineer*

Report No. 11
ALC 603 Angle of Attack Computation and Display System

This system embodies engineering experience in angle of attack computational equipment that dates back to 1949. SM/I's Relative Wind Transducers became the first in the industry to satisfy military specifications. Elements of the system are pictured below; a vertical scale or clock-type indicator may be used for visual display. The design of the computer permits numerous variations with minimum modification. In all versions, this sub-system utilizes our Force Balance Mach Number Sensor, noted for its sensitivity and accuracy. As many as four data output servos each employing an SM/I transistorized amplifier can be provided in the unit without altering its exterior configuration. The gear train will operate various combinations of pots, synchros and other output devices. Normally, two SM/I relative wind transducers are used. One measures indicated angle of attack; the other measures angle of side-slip. After Mach number and side-slip corrections are made in the compensator assembly, the output function is the True Angle of Attack.

General Specifications

Operating range:
Angle of Attack .... 50°
Angle of Yaw .... 50°
Airspeed .... 200 knots to 600 knots
Altitude .... —1000 ft. to 60,000 ft.
Accuracy: ±¼°
Electrical Power Requirements: 115V, 400 cycle @ 2.5 amps (including vane heaters)
Computer Size: 8⅜"x5½"; weight, 7 lbs. (including shock mount)


FUNCTIONAL SCHEMATIC OF A TYPICAL SYSTEM
α_L
α_i
β_L
β_i
$f_1(M)$
$f_2(M)$
A
B
CT
α_T
INDICATOR
RELATIVE WIND TRANSMITTERS
P_S
P_T
S
A
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MACH
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—when and where—

OCTOBER

National Electronics Conference and Exhibition, Hotel Sherman, Chicago, Oct. 10-12.

ARS Human Factors and Bioastronautics Conference, Biltmore Hotel, Dayton, Ohio, Oct. 10-12.

Society of Automotive Engineers, National Aeronautic Meeting, Ambassador Hotel, Los Angeles, Oct. 10-14.

IRE/ASQC Reliability Training Conference, Southwest Area, Lake Texoma Lodge, Kingston, Okla., Oct. 10-15.

Government Contracting Course, National Defense Education Institute, sponsored by National Security Industrial Association and Harbridge House, Inc., Washington, D.C., Oct. 10-21.

Third AFOSR Astronautics Symposium, sponsored by Air Force Office of Scientific Research, Society of Automotive Engineers, Ambassador Hotel, Los Angeles, Oct. 12-14.

American Vacuum Society, Seventh National Symposium, Cleveland-Sheraton Hotel, Cleveland, Oct. 12-14.

Optical Society of America, Fall Meeting, Boston, Oct. 12-14.

American Society for Quality Control, 15th Midwest Conference, Broadview Hotel, Wichita, Kan., Oct 14-15.

Society for Photographic Scientists and Engineers, Revolution in High-Speed Processing, Washington, D.C. Oct. 14-15.

Joint Meeting, Institute of the Aeronautical Sciences and Canadian Aeronautical Institute, Queen Elizabeth Hotel, Montreal, Oct. 17-18.

ASME-ASLE Lubrication Conference, Statler-Hilton Hotel, Boston, Oct. 17-19.

42nd National Metal Exposition and Congress, Trade and Convention Center, Philadelphia, Oct. 17-21.

American Ceramic Society, 13th Pacific Coast Regional Meeting, Ambassador Hotel, Los Angeles, Oct. 18-21.

Annual Meeting, Society for Experimental Stress Analysis, Hotel Claremont, Berkeley, Calif., Oct. 19-21.

Symposium on Space Navigation, Institute of Radio Engineers, Deshler-Hilton Hotel, Columbus, Ohio, Oct. 19-21.

Conference on Hypervelocity Projection Techniques, University of Denver, Institute of the Aeronautical Sciences, Denver, Oct. 20-21.

ASME-American Society of Mining, Metallurgical and Petroleum Engineers, Fuels Conference, Daniel Boone Hotel, Charleston, W.Va., Oct. 24-25.

Medical and Biological Aspects of the Energies of Space Symposium, sponsored by USAF Aerospace Medical Center, (ATC) Granada Hotel, San Antonio, Tex., Oct. 24-26.

Seventh Annual East Coast Conference on Aeronautical and Navigational Electronics, Lord Baltimore Hotel, Baltimore, Oct. 24-26.

Government Contracting Course, National Defense Education Institute, sponsored by NSIA and Harbridge House, Inc., Detroit, Oct. 24-Nov. 4.

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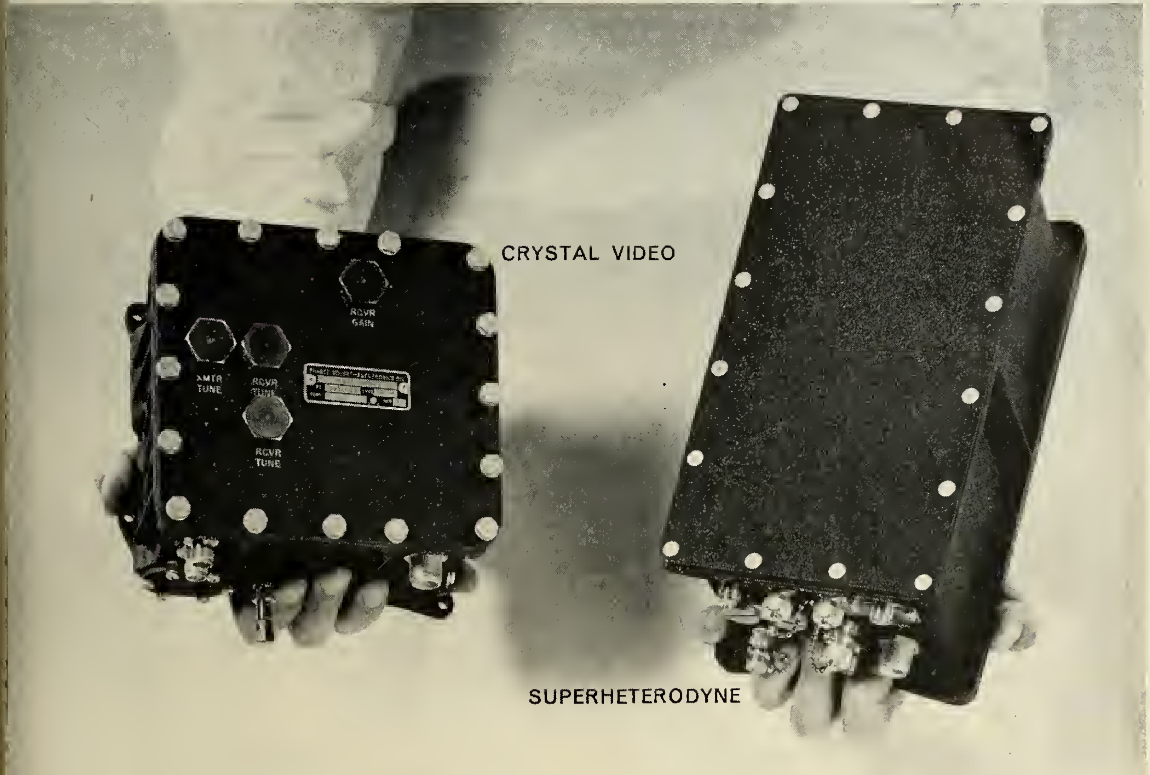

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To Sand and Dust
per Paragraph 4.11.1 Procedure 1
To 50 hour Salt Spray
per Paragraph 4.6 through 4.6.13
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per Paragraph 4.16.2 Procedure 2

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contracts

NASA

$173,050—General Dynamics Corp., Cleveland, for liquid oxygen, liquid nitrogen and gaseous oxygen for the Lewis Research Center.

$116,680—Linde Co., Cleveland, for liquid oxygen, liquid nitrogen and gaseous oxygen for the Lewis Research Center.

$59,699—Universal Marine Construction Co., Sandusky, Ohio, for electrical equipment and wiring at Plum Brook Facilities, Sandusky, Ohio.

$38,000—High Voltage Engineering Corp., Burlington, Mass., for neutral beam source for Lewis Research Center.

NAVY

Cryogenerators, Inc., subsidiary of **North American Philips Co., Inc.,** Ashton, R.I., for design, development, construction and testing of a low-pressure-cycle liquid-oxygen liquid-nitrogen generator. Amount not disclosed.

$8,000,000—Ryan Aeronautical Co., San Diego, for production of AN/APN-130 Doppler navigation sets.

$4,400,000—General Electric Co., Pittsfield, Mass., classified. (Three contracts).

$2,000,000—General Electric Co., Pittsfield, for production of fire control directors for the *Tartar* system.

$1,400,000—General Electric Co., Pittsfield, for manufacture of sea water batteries.

$495,000—Dorsett Electronics Laboratories, Inc., Norman, Okla., for manufacture of telemetering components for the *Terrier* and *Tartar* missiles. Subcontract from **Convair/Pomona.**

$492,900—Allison Div., General Motors Corp., Indianapolis, for design, development and initial production of an aerial target tow reel.

$250,000—Ramo Wooldridge, Los Angeles, for computer development.

$100,000—General Electric Co., Washington, for field service engineers for Mk 1 *Polaris* guidance system.

$75,000—Summers Gyroscope Co., Santa Monica, for guidance system components for the advanced version of the *Sidewinder*. Subcontract from **Motorola Inc.'s Military Electronics Div.**

$44,908—Cannon Electric Co., Los Angeles, for missile fire control system launching equipment.

AIR FORCE

Northrop Corp.'s Norair Div., Hawthorne, Calif., has received a "multimillion" dollar contract from **The Martin Co.-**Denver, for installation and checkout of *Titan* missiles and ground equipment at Ellsworth AFB.

Chance Vought's Astronautics Div., Dallas, for developing a restraint system to protect the space pilot against landing impact forces as high as 60 g's. System is being designed for advanced manned space vehicles. Amount not disclosed.

$8,938,436—Laboratory for Electronics, Inc., Boston, for components of the AN/ATN-131 radar set, spare parts and ground support equipment.

$6,000,000—Douglas Aircraft Co., Inc., Santa Monica, for components, spare parts, engineering and technical data for *MB-1 Genie*.

$1,800,000—Massachusetts Institute of Technology, Cambridge, for research and development.

$333,000—Sylvania Electric Products In Applied Research Laboratory, Waltha Mass., for research and experimentati involving electronic scanning stora techniques.

$250,000—Leach Corp., Compton, Calif., f ground support equipment for tacti *Titan* missile bases. Subcontract fr **The Martin Co.**

ARMY

$199,125,000—Western Electric Co., New Yo City, for development of the *Nike-Ze*

$29,597,535—Raytheon Co., Waltham, Mas for continued production of the *Ha* missile system, divided as follows: $1 900,000 for production; $8,065,000 f manufacture of ground support equi ment; $3,267,396 for engineering servic $1,374,139 for field maintenance and te equipment.

$20,000,000—Western Electric Co., New Yo City, for continued work on *Nik Hercules*.

$16,217,452—Hercules Powder Co., Wilmin ton, Del., for ($14,735,425) continu production of rocket items includi motors, propellants and explosives; ($ 482,027) varied items of propellants, e plosives and maintenance. (Two co tracts.)

$10,566,490—Raytheon Co., Waltham, Mas for production of *Hawk* missiles, divid as follows: $4,673,699 for ground supp equipment and maintenance test equi ment for NATO; $4,019,265 for produ tion of Hawk missiles for NATO; $ 873,526 for various equipment to used in the program.

**$5,640,375—Mason & Hanger, Silas Mas Co. Inc.,** New York City, ($2,472,224) f continued production of classified item ($1,996,782) classified and ($1,171,36 medium caliber rockets, components a maintenance. (Three contracts.)

$3,399,739—Liberty Powder Defense Corp., Alton, Ill., for various propellants a explosives. (Two contracts.)

$1,555,791—U.S. Rubber Co., New York Ci for various items, propellants, explosiv and maintenance.

$1,374,317—W. L. Maxson Corp., New Yo City, for further work on componen for the *Hawk* missile.

$1,286,749—Chrysler Corp., Detroit, for fu ther work on the *Redstone* missi system.

$1,000,000—Convair, Fort Worth Division, f radiation shielding for the crew of proposed combat vehicle.

$803,305—Perron Construction Co., Oak Par Mich., for construction of radar tow and appurtenances at the Port Austin Station.

$376,000—Colorado Research Corp., Broon field, Colo., for manufacture of speci digital television systems.

$285,362—Biltmore Construction Co. Clearwater, Fla., for construction of engineering and operations building Cape Canaveral Missile Test Annex, Pa rick AFB.

$127,284—Douglas Aircraft Co., Inc., San Monica, for procurement of *Nike* repa parts.

$119.046—Sperry Rand Corp., Salt Lake Cit Utah, for ground handling and te equipment and equipment training the *Sergeant* missile. (Three contracts

$100,000—California Institute of Technolog Pasadena, for research on hyperson wind tunnel.

$10,000—The Martin Co.-Orlando, for add tional research and development wo on the *Pershing*.

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ENGINEERS · SCIENTISTS

D Sinclaire M. Scala (Ph.D., Princeton, Theoretical Aero-
dy mics) has been engaged in research in the fields of high
te erature fluid flow since 1951. In 1956 he joined th
S e Sciences Laboratory. Here, he pioneered the ablatio
c ept as a solution to re-entry problems. In December
1 , he was appointed Manager, High Altitude Aero-
d mics. Dr. Scala has published more than 20 papers
r ed to missile and satellite re-entry problems. One of
th most recent, "Shock Wave Structure in a Relaxing Dia-
to c Gas" (with L. Talbot) appeared in the Proceedings
o e Second International Symposium on Rarefied Gas
D mics, Berkeley, Calif., August 1960.

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'If the Soviets Control Space . .

On these pages Sen. Kennedy blows the lid off the space/defense debate in the 1960 presidential race. Responding to M/R's open letter of last week, the Democratic nominee gets down to cases—calling for: 1.) national recognition of the strategic space race with Russia; 2.) reorganization of our defenses; 3.) immediate acceleration of ICBM programs. But he asks "elastic" dates on specific space projects. Vice President Nixon promises a reply soon.

by Senator John F. Kennedy

The space and defense proposals of MISSILES AND ROCKETS parallel, although in somewhat more detail, those of the Democratic Party platform. They are in line with my own thinking, our goals are identical.

My comments on the nine-point proposal of Sept. 27 follows. (M/R's points are in italics.)

1. Recognize as national policy that we are in a strategic space race with Russia.

We are in a strategic space race with the Russians, and we have been losing. The first man-made satellite to orbit the earth was named *Sputnik*. The first living creature in space was Laika. The first rocket to the moon carried a Red flag. The first photograph of the far side of the moon was made with a Soviet camera. If a man orbits earth this year his name will be Ivan. These are unpleasant facts that the Republican candidate would prefer us to forget.

Control of space will be decided in the next decade. If the Soviets control space they can control earth, as in past centuries the nation that controlled the seas dominated the continents. This does not mean that the United States desires more rights in space than any other nation. But we cannot run second in this vital race. To insure peace and freedom, we must be first.

2. Expedite present space projects to provide a new and bold program with the following goals; Manned space platform—1965; A U.S. citizen on the moon—1967-68; Nuclear power for space exploration—1968-69; A spacecraft which can take off from earth, travel to and in space, return and land under its own power—1968-69.

The target dates for a manned space platform, U.S. citizen on the moon, nuclear power for space exploration, and a true manned spaceship should be elastic. All these things and more we should accomplish as swiftly as possible. This is the new age of exploration; space is our great New Frontie

3. Recognize that "space for peaceful purposes" possible only if "freedom of space" is ensured; hen that the U.S. military must be given a predomina role in developing and carrying out the projec necessary to guarantee freedom of space.

Freedom of space must be assured, preferab by mandate of the United Nations. The Unit States must have pre-eminence in security as umbrella under which we can explore and develo space for the benefit of all mankind.

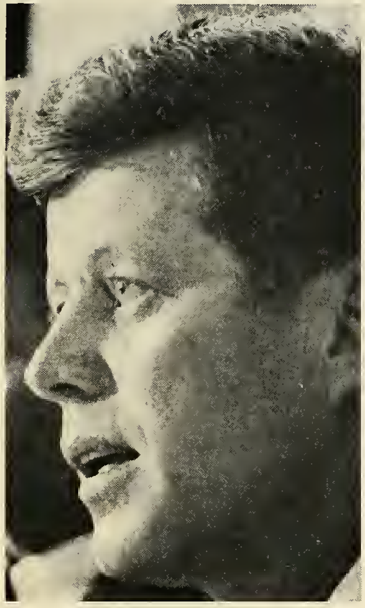
4. Establish pre-eminent strategic, tactical and d fensive forces with representation from all servic

Reorganization of the cumbersome, antiqu and creaking machinery of the Department of D fense is high on the agenda of the new Dem cratic administration. I have asked Senator Stua Symington to head an advisory committee whic by December 31 will give me recommendatio for this reorganization. Members of the committ include Thomas K. Finletter, former Secretary the Air Force; Clark Clifford, who assisted drafting the National Security Act of 194 Roswell L. Gilpatric, who was a member of th Rockefeller Special Studies Project; Fowl Hamilton, former member of the Joint Intelligen Staff of the Joint Chiefs of Staff; and Marx Lev a former Special Assistant to the Secretary of th Navy and Chairman of a Civilian-Military Revie Panel for a Senate Committee. Dr. Edward Welsh, economist, military analyst, and a Legi lative Assistant in the Senate for the past eig years, is Executive Director.

This committee will make practical recon mendations as to what changes should be ma in the organization and administration of our d fense agencies to eliminate the present cripplin effect of those problems upon our power.

The Democratic Platform calls for reorganiz tion of the Department of Defense according functions and missions. The committee will ce

ney Can Control Earth' –Kennedy



'. . . billions
an be saved by
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nd minimizing
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ween services."

tainly study the feasibility and efficiency of: (a) A Strategic Command of such power and flexibility that it will deter surprise attack or major war—and indeed make it apparent to an enemy that surprise attack would be suicide; (b) A Tactical Command of strength and mobility capable of stamping out brush fire wars with speed and certainty; (c) A Continental Defense Command; (d) A Material Command, and (e) A Development Command.

Until 1945 major wars could be won by adhering to the principles of Napoleon, Nelson, Grant, Lee, Jackson and Sheridan. The atom has changed war, as it will change the world. We must have a modernized defense establishment to cope with the atomic age.

. Recognize the necessity of greater defense fund-
g to accomplish this, including a supplemental
udget in January, 1961, to make it possible to: Speed
p to a maximum degree the construction of ICBM
unching bases, Polaris submarines and the Mach 3
issile-carrying B-70. Provide the Army with funds
begin the immediate procurement of already-de-
eloped modern missiles, other weapons and airlift.

Defense spending must be based on the security needs of the nation, not the pre-determined confines of a budget. While more money will be spent for modernity and mobility in our armed forces, I believe that billions can be saved by streamlining the Department of Defense and minimizing competition between services. Our competitors lie on the other side of the Iron Curtain.

In January, I will send to the Congress specific requests to:

–Accelerate our *Polaris, Minuteman,* and other strategic missile programs.

–Expand and modernize our conventional forces, giving them the versatility and mobility they require.

–Protect our retaliatory capacity from a knockout blow through hardening and dispersal of bases, the use of an air alert, and improvements in our air defense system.

–Streamline our defense establishment to give immediate reaction in this nuclear space age.

We must do more on antisubmarine warfare. Russian submarines equipped with missiles can threaten even our inland cities. We must speed up development of space warning systems and an antimissile weapons system.

6. Establish further-on defense spending by need and not by budget ceiling.

My position on this is expressed in No. 5. I add this. Basic research must be encouraged and expanded, on a long-range budget plan. Research cannot be started and stopped according to the whims of the budgeteer. A "break through" in a vital field may be achieved in five years—or ten—but no one can be sure until it happens.

7. Streamline defense regulations and procedures to make industry's role in the U.S. defense and space effort more effective.

Certainly defense regulations and procedures must be simplified, and the proliferation of secretaries, assistant secretaries, under-secretaries, special assistants and deputy assistants to secretaries, boards, commissions, councils, and committees must be rolled back. The Symington group is now hard at work on this tangled maze.

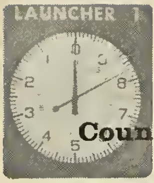
8. Take what steps may be necessary to establish and promote national scientific objectives.

Certainly national scientific goals will be our first objectives, continuously emphasized.

9. Re-establish decision-making in the U.S. defense and space organizations.

The Democratic Party has strength in depth among dedicated men familiar with defense problems. They will have a mandate to speed the decision-making process, and authority to make affirmative decisions very quickly. ⌗

(See editorial—Page 50.)



Countdown for Survival

M/R Readers Give Their Views

Emphasis on U.N.

To the Editor:

Congratulations on your open letter to the two presidential candidates challenging them to make space an important issue of the campaign. It's about time someone in a responsible position tried to awaken them to the crucial cosmic problems of the day.

However, I am disturbed at your general thesis, which seems to be parroting ex-General John B. Medaris' bitter memoirs, *Countdown for Decision,* which was just published. Basically, your logic seems to rest on a plea for giving the military the "predominant role in developing and carrying out the projects necessary to guarantee freedom of space" at the expense of NASA, which is relegated to a minor "promotion of scientific objectives," placed next to the bottom of your eight-step proposal.

With the current great debate taking place at the "rump summit" at the U.N. General Assembly meeting in New York stressing the dire need for immediate agreement on disarmament proposals—including control and inspection, it would seem to me that granting the U.S. military a larger role in space than it already has would only run counter to the trend of the debate in the U.N. and would tend to possibly inflame the neutral nations as well as Mr. K.

If our two presidential candidates would only consider the potential moral, strategic and tactical advantages of proposing (as you suggested in the last paragraph of your editorial) that, "If this defense of the freedom of space can be under the aegis of the United Nations, as it should be, that is fine," then we might have some hope of regaining the leadership initiative in the world that we have lost.

And who is to really say that the Russians will NOT provide any weapons or space vehicles necessary to do the policing for the U.N.? Let's not underestimate Mr. K! For all his vaudeville balcony antics, he is a shrewd politician who realizes the power of space propaganda. He has consistently played down the military aspects of the Soviet space experiments and stressed the scientific values, which he will undoubtedly do when he triumphantly announces the name of the world's first (Soviet) astronaut and his successful orbiting of the earth.

If Messrs. Kennedy and Nixon would only go on record in favor of carrying the President's four-step U.N. space control proposals one step farther—to make available American vehicles, tracking stations, ground equipment, launching pads and personnel for the establishment of a U.N. space program NOW, before it is too late, then we might be able to sleep better nights. And we wouldn't have to fear any Cosmic Curtains being dropped over our heads. Impossible? A dramatic plea before the U.N. General Assembly by either one or both of the candidates is still not out of the question—before election day!

Dr. Donald Cox
Rutherford, N.J.

MISSILES AND ROCKETS *is providing a forum here to focus attention on the space/defense issue in the presidential campaign—and after the election. This is an issue which the editors feel warrants much greater attention by the nation's leaders and the American public.*

Readers are invited to express their views on the vital questions of how this nation is to win the strategic space race with Russia. Correspondence should be addressed to:

Countdown for Survival
Missiles and Rockets
1001 Vermont Ave., N.W.
Washington 5, D.C.

Antimissile Defenses

To the Editor:

Although your proposal is comprehensive, I am somewhat surprised by the absence of a well defined position by MISSILES AND ROCKETS as it relates tc an antimissile defense.

Our deterrent to Soviet nuclear attack upon the United States requires a prope balance between offensive and defensiv means, and we must continue to improv both.

Defense against the intercontinenta ballistic missile is a vital part of ou whole concept of nuclear deterrent. Thi element of our deterrent will become increasingly important as the Soviet capability in ICBM's continues to grow, an will be even more essential if the Soviet should achieve an antimissile defense o their own at an early date.

The early achievement of an effectiv antimissile defense must be one of ou highest priority requirements for our national survival.

William W. Quinn
Major General, GS
Chief of Information
Department of the Arm
Washington

Argument for Flexibility

To the Editor:

I have read your open letter to M Nixon and Mr. Kennedy with great interest.

There is reason for concern as to th adequacy of our current military an space programs. Technological progress i proceeding at a progressively increasin rate, weapons and vehicles of all sorts ar becoming more complex and the cost c research and development, as well as production, is going ever upward.

As to military weapons and system many that we rely upon today are alread approaching the threshold of obsole cence. The speed of new developments ca be appreciated by the spectacular succe of the *Polaris* program.

It is obvious that these things mea greater expenditures in the future if w are to maintain our military strength. is encouraging to note that both M Nixon and Mr. Kennedy have recognize this.

It must not be forgotten that in re search and development new and unfor seen problems arise. It is generally im possible to plan a realistic budget f such programs. Research and developme funding should be based on need and c built-in flexibility which will provide fun ing for new problems when they aris We would never have got the atomic bom on a budget.

It is difficult to distinguish betwe

(Continued on page 48)

Nixon's Reply Coming

The open letter from MISSILES AND ROCKETS to both Presidential candidates was delivered on the same day—Sept. 27.

When the reply from Senator Kennedy was received, Mr. Nixon's headquarters was apprised of this fact.

As M/R went to press, word from the Vice President was that a reply to the open letter was being prepared and would be ready for a subsequent issue—probably next week.

M/R Exclusive . . .

Red China May Have Missile Subs

by Frank G. McGuire

QUEMOY—Communist China is ilding up a missile-launching subarine fleet, according to reports from S. and Nationalist Chinese intellince sources here.

The Red Chinese are said to have erational a Zulu-class submarine odified to launch two Soviet-designed issiles, designated as *T-10*. These mises, carried vertically in the sail of e submarine, are armed with highloton-yield nuclear warheads, accordg to U.S. officers, but cannot be unched from underwater.

According to information here, the bmarines must return to port for any -supply of missiles. Rapid modifican of the Zulu-class vessel allowed ne only for installation of basic capalities in missile launching, without ovisions for re-supply at sea.

Although sources were reluctant to scuss the *T-10* in detail, there were rong indications that its fuel is a liquid orable kept in the missile tanks to oid necessity for handling fuels at a.

• **"Getting bolder and better"**—stimates of the total number of subarines in the Red Chinese navy range from 20 to 50, with an undisclosed portion of these modified for missile launching. Some submarines are believed to carry missiles other than the *T-10*, but again, numbers were not disclosed.

Admiral Harry D. Felt, Commander in Chief, Pacific (CINCPAC) said the Communist submarine force in the Pacific numbers about 120 to 160, with 100 to 110 being Russian naval units.

"Their submarines are getting bolder and better," he said, "and we're seeing more and more of them out here. They don't seem to be conducting as much reconnaissance with their Pacific submarine fleet as they are with their Atlantic fleet, however."

He pointed out that development work of a missile-launching submarine "has been proceeding well" in the Communist naval forces, but did not mention the *T-10* by name.

• **More in arsenal**—In addition to the *T-10*, other missile and rocket threats faced by the Nationalist Chinese include:

–*GVAI* tactical bombardment rockets emplaced on the mainland and other Communist-held islands near Quemoy. These weapons, barrage types, are fired in salvoes from multiple-tube launchers. They are being replaced in Soviet military units, and now are used by other Communist forces.

–Air-to-ground rockets used for strafing by Mig-17 jet aircraft. These unguided rockets of the *Mighty Mouse* class have been fired on Quemoy during raids by Communist Chinese jets.

–Large surface-to-surface missiles are being deployed opposite Quemoy in Fukien province, reportedly the most heavily militarized province on the Chinese mainland. Types are not definitely known, but probably consist of the *T-5*, *T-5B*, and other tactical missiles with ranges of less than 1000 miles.

• **Chiang would welcome big missiles**—At a Taiwan press conference, President Chiang Kai Shek said in response to an M/R question that he doubts the Red Chinese will have their own nuclear capability within three years.

"Any such weapons they acquire within the next three years will come from Russia," he said.

He indicated the Republic of China would welcome strategic missiles on Taiwan to counter the expected buildup on the mainland. ⁂

The Missile/Space Week

GE Claims Defense Work Moving Well

The first week of a nationwide strike against General lectric left its defense business largely unhampered, ompany officials said. The midweek picture: Flight ropulsion Div., Cincinnati, participating unions voted ot to strike; MSVD, Philadelphia, no picketing; Burlingon, 90% production; Electronics Park, Syracuse, some icketing but plants continued to operate; Lynn, Mass. aircraft engine), heavy picketing but work continuing.

The International Union of Electrical Workers deanded a two-year contract with wage increases of ½% each year. It also called for supplementary unemloyment benefits, improved vacation and holiday schedles, a union shop, and continuation of a cost-of-living scalator clause. GE's three-year counterproposal ofered a 3% immediate raise and another of 4% on April 2, 1962. It also offered a retraining plan for workers who lose their jobs because of lay-offs or plant closings and proposed improved pension and insurance plans.

BOB Releases More Money

The Administration is continuing to dip into the $621 million added by Congress to the '61 defense budget. In its annual mid-year review, the Bureau of the Budget estimated it will increase Fiscal 1961 spending for military procurement by some $350 million.

Last week, DOD released $169 million added by Congress. This leaves $449 million to be obligated. A $150-million R&D boost for *Samos* and the 2400-mile *Polaris* plus an $87-million increase in obligational authority for missiles were included.

The extra money for missiles will go to *Minuteman* and a step-up in *Polaris*. A major increase of $345 million for two additional *Polaris* systems is listed as available for obligation and an added $540 million for aircraft procurement may go partly to the B-70.

Trudeau says Army Must be Given t

R&D chief, in exclusive interview, also calls for more air transport for missiles, closing the lead-time gap, step-up in basic research, and preparation for chemical war

by James Baar

LT. GEN. Arthur G. Trudeau, chief of Army R&D, bluntly contends that today there is "no sense" in anyone but the Army developing a land-based, 1000-mile-range tactical missile.

At the same time, the tough, intellectual general said in an interview that gave a preview of Army R&D trends:

–The next generation of Army missiles must be even more "air-transportable" than the latest one. The goal is the rapid movement of missiles in light Army STOL and VTOL planes.

–The three-to-four-year lead-time gap between U.S. and Soviet R&D weapon programs must and can be closed anytime there is sufficient support to do it.

–The military services must do more work in basic research, but even greater work of this kind must be taken on by industry.

–The United States must be prepared to meet the Soviet threat of waging chemical and biological war. Many military men contend it could be the cheapest weapon system available.

The 58-year-old general talked as he relaxed with a cigar in his Pentagon office. It was late in the afternoon and fall sunlight cast the shadows of models of Army missiles across the carpet.

He made the Army's case for developing a 1000-mile-range missile in cold, sledgehammer sentences.

"A field commander must be able to reach out at anything the enemy is throwing against him," he said. "He should have the ability to use his weapons without having to go through a dozen channels. Otherwise the target is gone—or he's clobbered.

"The Russians, of course, have missiles all the way up from short-range to ICBM's. And all are under the control of the Red Army."

Trudeau did not discuss specific competing programs. However, his remarks clearly supported Army proposals to develop a 1000-mile-range *Pershing II* and brushed aside Air Force proposals to develop a 1000-mile tactical-range missile known as the *TBX*.

• **The last 15 minutes**—Turning to strategic considerations, Trudeau noted bitingly that some military men saw little need for an Army at all.

"If you subscribe to the theory that any war means a nuclear exchange and
that will be all, and if we're to
down and cry in our beer becau
our cities have been bombed, then th
are right," he said.

"But I say no matter what happe
we can do something about it. V
must have the will and ability to fig
to a conclusion. And as Marshal Fo
once said the battle is won by t
Army fighting the last 15 minutes."

• **Doubts on obsolescence**—Mo
over, Trudeau, said, any future w
will not necessarily involve nucle
weapons or missiles of any size.

"The day of conventional artille
is not over for close-in combat
20,000 to 25,000 yards," he said. '
can fire accurately under any weath
conditions, it can fire continuously a
an artillery round costs only a fracti
of what a missile costs.

"I can conceive of nothing tod
in missiles that doesn't cost more th
$1000 a round as compared to le
than $100 for artillery. Therefore,
artillery shell with a nuclear warhe
has a very great appeal. If nucle
weapons are ruled out, it can be abs
lutely the best bet."

Trudeau grinned.

"This is an interesting thing abo
the Congo," he said. "It shows that
weapons become obsolescent but no
becomes obsolete.

"The bush knife and the spear a
pretty effective in Africa. Life is chea
And a man doesn't make much noi

ARMY'S PERSHING tactical missile on its transporter-erector-launcher. The Army wants to develop the Martin missile into a 1000-mile-range version. The Air Force wants to build a 1000-mile-range bird of its own.

00-mile-range Missile

ing them."

• **Plea for basic research**—The neral then turned his thoughts to &D problems. He said the nation has tremendous need for more basic rearch, but the need is not appreciated.

"Instead, there is a tendency to t down on basic research," he said. 'eople think that with all this techology everything is going to be hunkyry. I don't think it is.

"We are just beginning to learn mething about materials and eleconics, for instance. But, even with this w knowledge that we have, little mmercial use is made of it. Inistry's idea is to keep equal or just ead of the competition—no more fort is needed."

Trudeau took a puff of his cigar d shook his head.

"We are fighting for survival ainst Russian technology," he said. ndustry has got to be more interested basic research. A fair number of mpanies are. But more should be—ther than wait for the government to nd it.

"The smart company puts a reasonly fair share of its profits back into sic research."

• **Money bind**—Lastly, Trudeau ok up the Army's small share of the fense budget.

"Funding directly affects this busiss of lead-time in developing a eapon," he said.

"We showed what we could do in e *Davy Crockett* program. We had eryone behind it. There were no adblocks. It was always adequately nded. A task force was set up under lieutenant colonel who reported any oblems directly to me. The job was ished in less than three years."

Trudeau said this could be repeated ytime that the necessary conditions n be fulfilled. But he noted that in cent years funds have been so tight at the Army has been unable to buy rge quantities of the new weapons ready developed.

"We're so poor that there is great essure to spend our dollars on eapons already proven rather than on eveloping new ones," he said.

It was not said in a tone of comaint. He was merely stating a fact—commodity with which his career ows he has dealt with the utmost spect.

• **Man of many parts**—Trudeau is mething of a Renaissance man.

He was graduated from West Point in 1924 as an engineer and until World War II served in the Corps of Engineers, taking part in a number of large public works projects. In World War II he became one of the nation's leading experts in amphibious warfare. After the war, he became a schoolmaster and a student of economics when he served as deputy commander of the Army War College.

Earlier in his life, he missed seeing battle because two major combats in which he would have been involved failed to materialize; he was in command of a base preparing for the assault on Japan in 1945 and in command of the troops in Germany who were scheduled to break through to blockaded Berlin in 1948. But during the Korean War he assumed command of the 1st Cavalry Division in Japan and the 7th Infantry Division in Korea.

Later he became chief of Army Intelligence and traveled the world as a military diplomat. Finally, he became chief of R&D in 1958.

This short, heavy-set general and engineer and scholar has always been a good athlete as well. He played polo until he was past 40. He still plays golf in the low 80's.

He is a musician. He has played guitar with his left hand most of his life. He writes light verse.

He is very religious. When in Washington, he attends mass daily at the Roman Catholic Chapel at Ft. Meyer, Va., where he and his wife live.

He is an orator whom the Army has used repeatedly to impart its ideas to the public. Since becoming chief of Army R&D, he has made several-score major speeches a year.

• **"No status quo"**—It is in these speeches that he has expressed much of his hard-driving personality, much of a great belief in character and will.

In one speech earlier this year he said: "The tides of history cannot be contained and there is no status quo. Unless we have the urge to push onward and upward, we shall be thrust back."

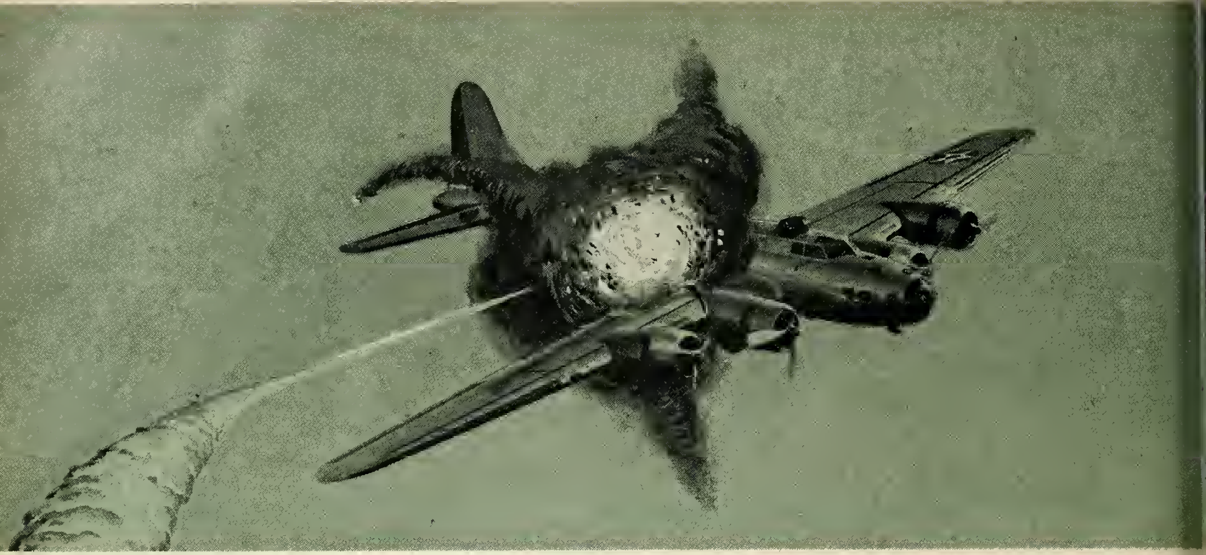
But possibly he made his thoughts even plainer in a recent article that he wrote for *Orbis*, the journal of the University of Pennsylvania's Foreign Policy Research Institute.

"We are all teammates in this relay race against the stopwatch of history and the price of defeat is oblivion and slavery . . . ," he wrote.

"THE RUSSIANS, of course, have missiles all the way up from short-range to ICBM's. And all are under the control of the Red Army."

"I can think of no better way to assert what I believe our national spirit should be today than to echo the words of another Vermonter of earlier days. When Ticonderoga fell to the Green Mountain Boys, the Continental Congress in its timidity considered giving the captured cannon back to the British, whereupon Ethan Allen wrote Congress a letter saying:

"'I wish to God America would at this critical juncture exert herself . . . She might rise on eagle wings and mount up to glory, freedom and immortal honor if she did but know her strength.'" ⌘



An M/R Directory

MOBILE MISSILE PLATFORMS

Aircraft on both sides of the Iron Curtain are bristling with a wide variety of missiles—next step: missiles to be launched by spaceships

AIRCRAFT TODAY is providing the air forces of the world with the most mobile of all available missile platforms

U.S. Air Force tactical aircraft are armed with Martin air-to-surface *Bullpups,* and air-to-air Hughes *Falcons,* GE-Philco *Sidewinders* and Douglas *Genies.*

SAC bombers already carry the 500-mile-range North American *Hound Dog.* And by the mid-'60's the B-52 and B-70 are scheduled to carry the 1000-mile-range Douglas *Sky Bolt.*

Overseas, British aircraft are armed with air-to-air de Havilland *Firestreaks* and *Red Tops* and air-to-surface Avro *Blue Steels.* French aircraft are armed with air-to-air *AA-20's* and Matra *R-511's.*

Swedish aircraft are carrying air-to-surface Robot *304's.* Italian planes bristle with SISPR *C-7's.*

Many NATO nations use *Sidewinders* on their interceptors. The British plan to deploy *Sky Bolts* aboard their V-bombers.

On the other side of the Iron Curtain, Soviet bombers carry *Komet D* air-to-surface missiles. Soviet interceptors are armed with the air-to-air *M-100D.*

The Russians are reported to be developing a nuclear-powered aircraft. Such a plane would be certain to carry air-to-surface missiles.

The next step for both East and West: Development of missiles to be launched from spacecraft.

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THE MISSILE/SPACE WEEKLY

1001 Vermont Avenue, N.W.,
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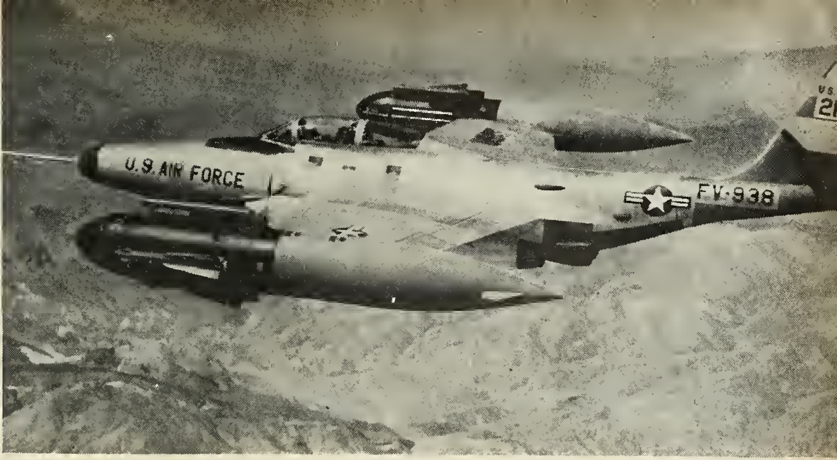
United States

F-89 SCORPION

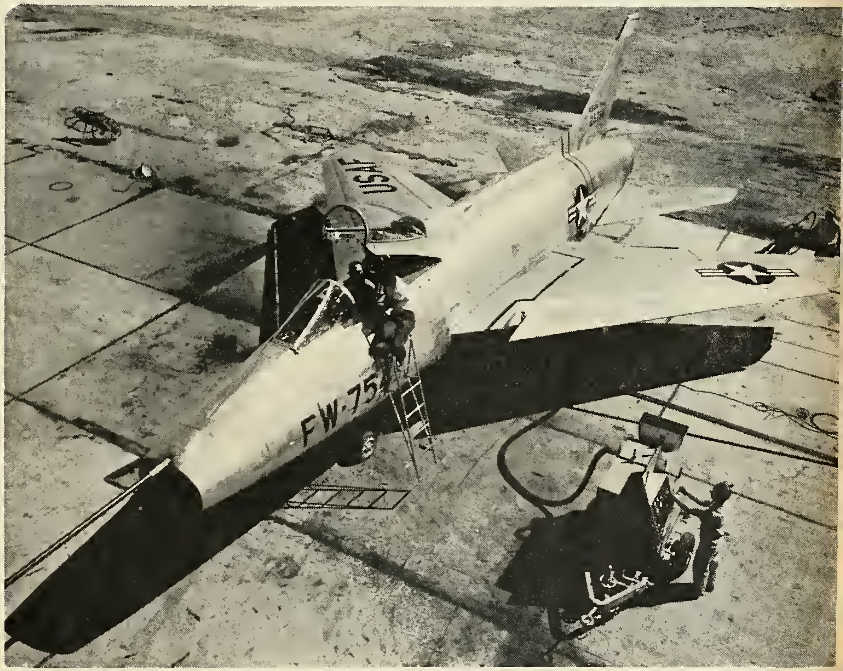
Type: Interceptor.
Prime contractor: Northrop Corp.
Armament: Two Genies; two 52-rocket pods of folding fin air-to-air rockets.
Performance: SPEED—more than 600 mph. CEILING—more than 45,000 ft. RANGE—more than 1000 miles.
Powerplant: CONTRACTOR—Allison. TYPE—J35-A-35 turbojet with after burner. NUMBER—two.
Deployment: Air Defense Command, Air National Guard.
Remarks: Being phased out in favor of more advanced interceptors of 100 series.



F-89 SCORPION

F-100 SUPERSABRE

Type: Tactical fighter.
Prime contractor: North American Aviation, Inc.
Armament: Four GAR 8 Sidewinders; four M-39 20 mm. cannon; HE or nuclear bombs.
Performance: SPEED—more than 800 mph. CEILING—more than 50,000 ft. RANGE—more than 1000 miles.
Powerplant: CONTRACTOR—Pratt & Whitney. TYPE—J-57 P-21 with afterburner.
Deployment: Tactical Air Command, USAF in Europe and Pacific, Air National Guard.

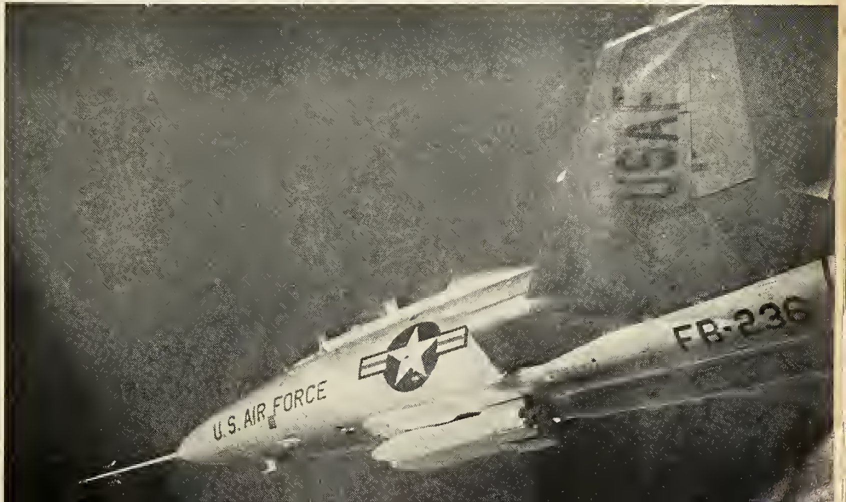


F-100 SUPERSABRE

F-101B VOODOO

Type: Tactical fighter.
Prime contractor: McDonnell Aircraft Corp.
Armament: Combinations of 2 Genies or 2 GAR 2A Falcons, and four M-39 20 mm. cannon; HE or nuclear bombs.
Performance: SPEED—more than 1200 mph. CEILING—more than 50,000 ft. RANGE—more than 1000 miles.
Powerplant: CONTRACTOR—Pratt & Whitney. TYPE—J-57. NUMBER—two.
Deployment: Tactical Air Command, Air Defense Command, USAF in Europe and Pacific.

F-101B VOODOO



MOBILE MISSILE PLATFORMS

F-102 DELTA DAGGER

Type: Interceptor.
Prime contractor: Convair Division of General Dynamics Corp.
Armament: Six GAR 1B or 6 GAR 2A, Falcons plus 24 Z-7S folding fin air-to-air rockets.
Performance: SPEED—supersonic. CEILING—more than 50,000 ft. RANGE—more than 1000 miles.
Powerplant: CONTRACTOR—Pratt & Whitney. TYPE—J-57-P-23 turbojet with afterburner.
Deployment: Air Defense Command.

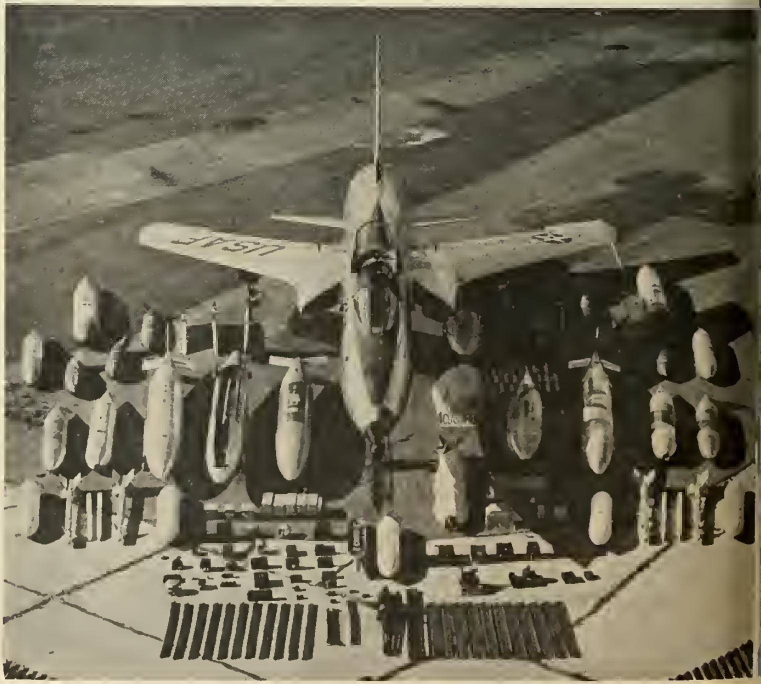
F-102 DELTA DAGGER

F-104 STARFIGHTER

Type: Interceptor, tactical fighter
Prime contractor: Lockheed Aircraf
Corp.
Armament: 2 GAR-8 Sidewinders
HE or nuclear bombs.
Performance: SPEED—more tha
1400 mph. CEILING—more tha
90,000 ft. RANGE—more tha
1000 miles.
Powerplant: CONTRACTOR—General Electric. TYPE—J-79 wit
afterburner.
Deployment: Air Defense Command
Tactical Air Command.

F-105 THUNDERCHIEF

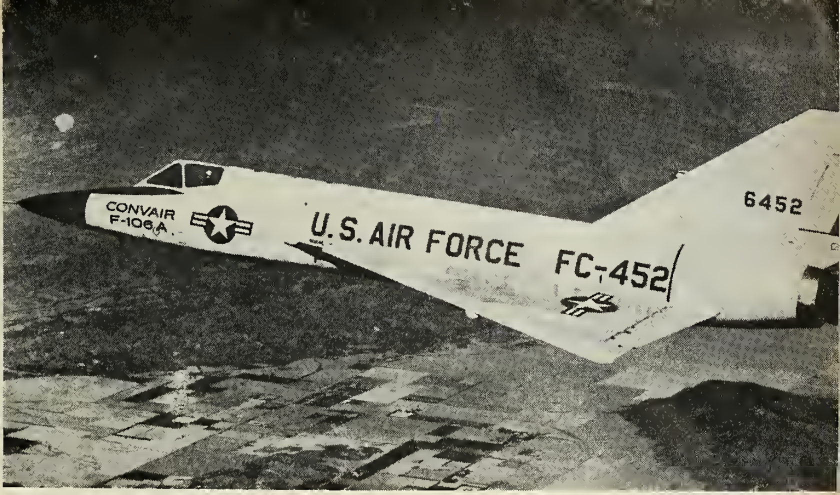
Type: Tactical fighter.
Prime contractor: Republic Aviation Corp.
Armament: Combinations of Sidewinders, Falcons, rockets; 4000 lbs. of HE or nuclear bombs.
Performance: SPEED—more than 1200 mph. CEILING—more than 55,000 ft. RANGE—more than 1500 miles.
Powerplant: CONTRACTOR—Pratt & Whitney. TYPE—J-75 with afterburner.
Deployment: Tactical Air Command.



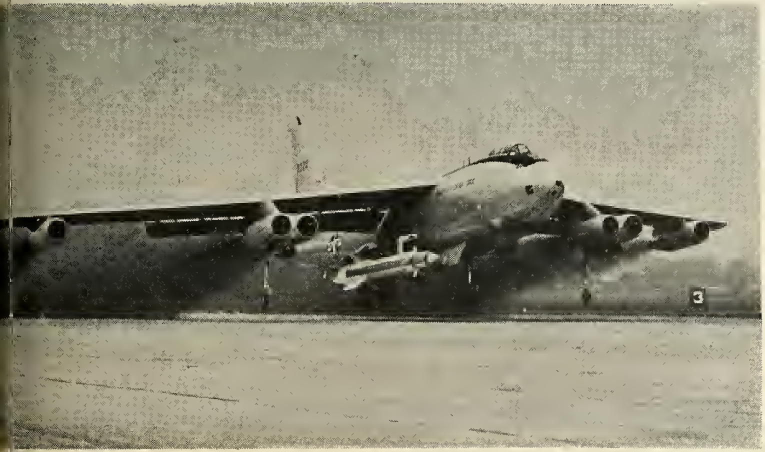
F-105 THUNDERCHIEF

F-106 DELTA DART

Type: Interceptor.
Prime contractor: Convair Division of General Dynamics Corp.
Armament: 1 Genie and 4 GAR 3A or 4A Falcons.
Performance: SPEED—more than 1400 mph. CEILING—more than 50,000 ft. RANGE—about 1500 miles.
Powerplant: CONTRACTOR—Pratt & Whitney. TYPE—J-79-9 turbojet with afterburner.
Deployment: Air Defense Command.



F-106 DELTA DART



B-47 STRATOJET

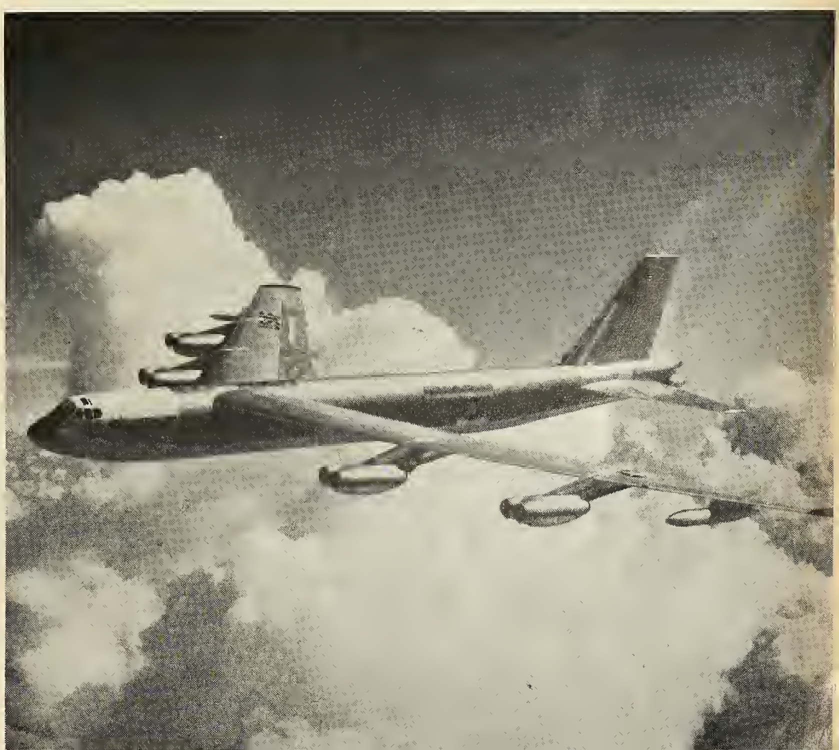
Type: Strategic medium bomber.
Prime contractor: Boeing Airplane Co.
Armament: Quail, two 20 mm. cannon in tail turret, more than 20,000 lbs. of HE or nuclear bombs.
Performance: SPEED—more than 600 mph. CEILING—more than 40,000 ft. RANGE—more than 3000 miles.
Powerplant: CONTRACTOR—General Electric. TYPE—J-47. NUMBER—six.
Deployment: Strategic Air Command bases overseas.
Remarks: B-47's are being phased out for B-58's.

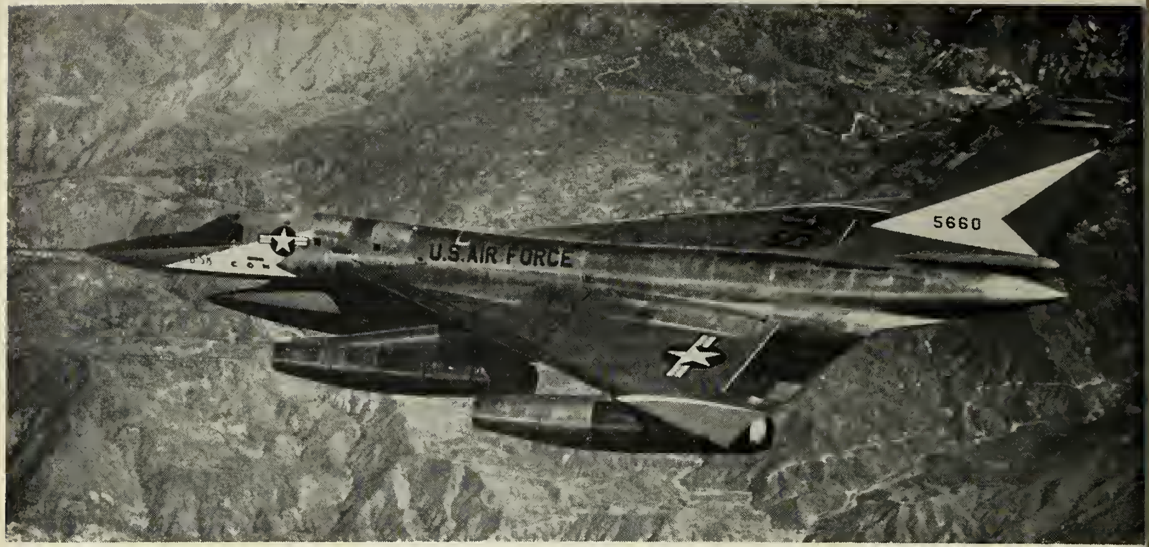
-47 STRATOJET

B-52 STRATOFORTRESS

-52 STRATOFORTRESS

ype: Strategic heavy bomber.
rime contractor: Boeing Airplane Co.
rmament: Two Hounddogs, Quail; more than 20,000 lbs. of HE or nuclear bombs. H models will carry Sky Bolts.
erformance: SPEED—more than 600 mph. CEILING—more than 50,000 ft. RANGE—(A to F series) more than 6000 miles; (G) more than 7500 miles; (H) more than 9000 miles.
owerplant: CONTRACTOR—Pratt & Whitney. TYPE—J-57 turbojet. NUMBER—eight.
eployment: Strategic Air Command bases in the United States and Puerto Rico.
emarks: B-52's also are used as a launching platform for X-15 rocket planes.





B-58 HUSTLER

MOBILE MISSILE PLATFORMS

B-58 HUSTLER

Type: Strategic medium bomber.

Prime contractor: Convair Division of General Dynamics Corp.

Armament: Sky Bolts, three 20 mm. cannon; HE or nuclear bombs.

Performance: SPEED—Mach 2. CEILING — more than 60,000 ft. RANGE — "intercontinental through midair refueling."

Powerplant: CONTRACTOR—General Electric. TYPE—J-79. NUMBER—four.

Deployment: First operational squadrons are stationed at Carswell AFB, Tex.

Remarks: B-58 has been considered as a carrier for Sky Bolts but this has yet to be decided.

B-70 VALKYRIE

Type: Strategic bombe

Prime contractor: North Americ Aviation, Inc.

Armament: Sky Bolts; nuclear bomb

Performance: SPEED—Mach 3. CEI ING — more than 70,000 f RANGE—intercontinental.

Powerplant: CONTRACTOR—Ge eral Electric. TYPE—J-93 turb jets. NUMBER—six.

Deployment: Possibly 196

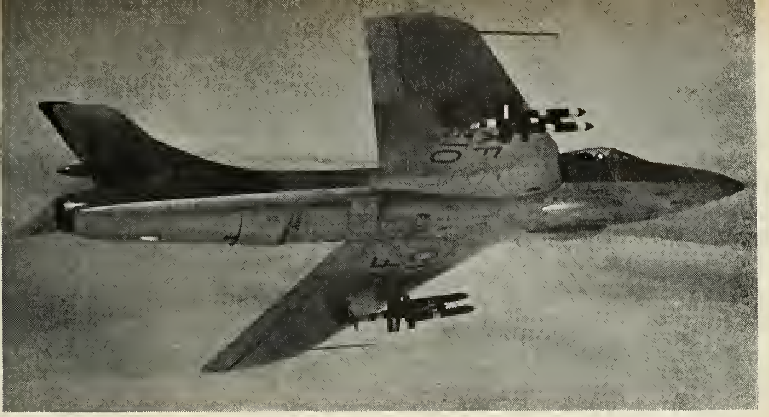
Remarks: The B-70 program has bee reinstated as a full R&D project

B-70 VALKYRIE

Great Britain

HUNTER F.6

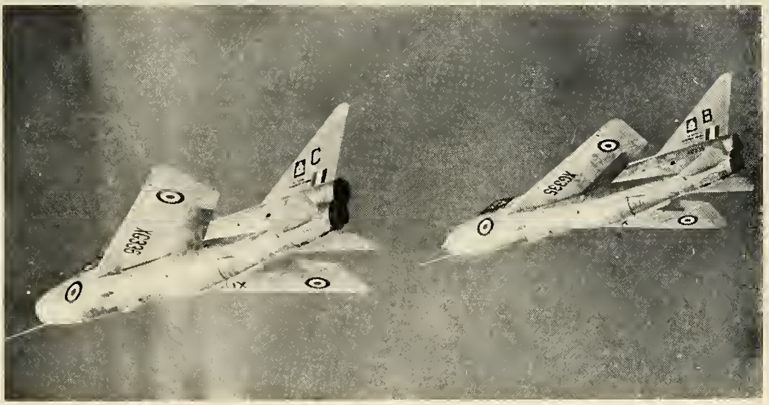
Type: Interceptor, fighter.
Prime contractor: Hawker.
Armament: Fireflashes; 24 3 in. rockets; four 30 mm. cannon; four 500 lb. or 1000 lb. bombs.
Performance: SPEED—more than 700 mph. CEILING—55,000 ft. RANGE—550 miles.
Powerplant: CONTRACTOR—Rolls Royce. TYPE—Avon 200.
Deployment: RAF bases in Britain.



HUNTER

LIGHTNING P.1

Type: Interceptor, fighter.
Prime contractor: English Electric.
Armament: Two Firestreaks, two 30 mm. cannon.
Performance: SPEED—more than Mach 2. CEILING—more than 60,000 ft. RANGE—not available.
Powerplant: CONTRACTOR—Rolls Royce. TYPE—Avon R.A. 24R turbojets. NUMBER—two.
Deployment: RAF fighter squadrons in Britain.



LIGHTNING

VULCAN B.2

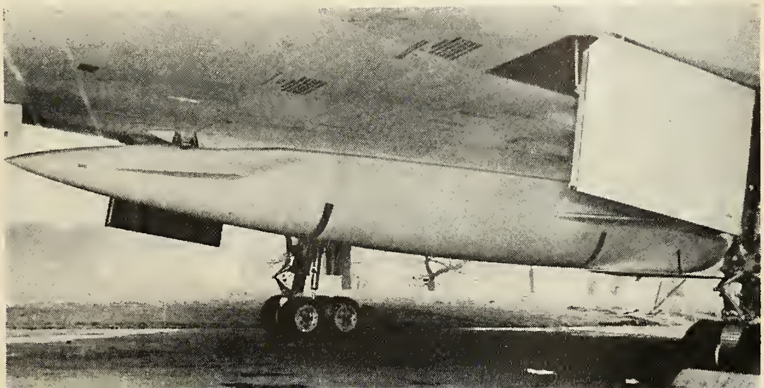
Type: Long-range medium bomber.
Prime contractor: Avro.
Armament: Sky Bolts; HE or nuclear bombs.
Performance: SPEED—about 630 mph. CEILING—about 60,000 ft. RANGE—more than 3000 miles.
Powerplant: CONTRACTOR—Bristol. TYPE—Olympus 201. NUMBER—four.
Deployment: RAF bases in Britain.

VULCAN

VICTOR B.2

Type: Long-range medium bomber.
Prime contractor: Handley-Page.
Armament: Sky Bolts; HE or nuclear bombs.
Performance: SPEED—more than 600 mph. CEILING—50,000 ft. RANGE—more than 3000 miles.
Powerplant: CONTRACTOR—Rolls Royce. TYPE—Conway R. Co. II. turbojets. NUMBER—four.
Remarks: Victor B.I's are deployed at RAF bases.

VICTOR



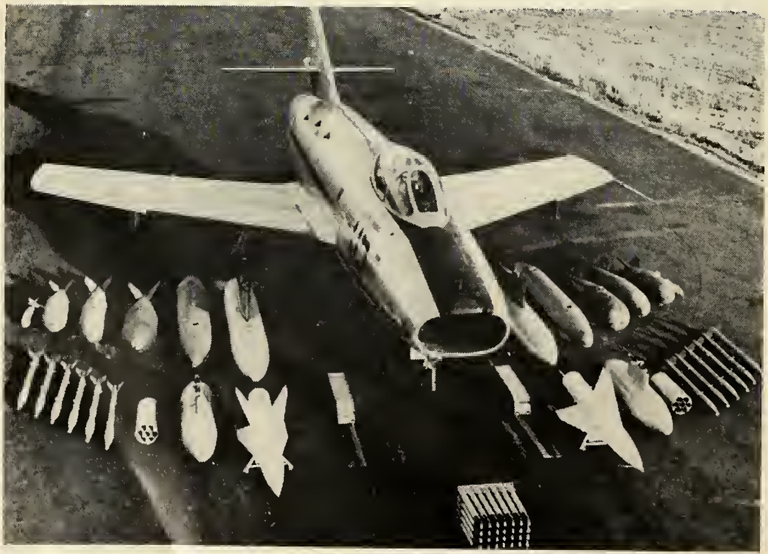
MYSTERE

MIRAGE

France

VAUTOUR

Type: Fighter.
Prime contractor: Sud-Aviation.
Armament: Four MATRA 5103's or 511's or four missile pods containing 19 folding fin rockets each; four 30 mm. cannon; two MATRA packs containing 232 68 mm. SNEB folding fin rockets; some models carry bombs.
Performance: SPEED—686 mph. CEILING—44,000 ft. RANGE—3700 miles.
Powerplant: CONTRACTOR—SNECMA. TYPE—Atar 101E-3 turbojets. NUMBER—two.
Deployment: French Air Force.



SUPER MYSTERE

MYSTERE IV-A

Type: Interceptor, fighte
Prime contractor: Dassaul
Armament: MATRA magazine wi 55 rockets; two groups of 6 ai to-ground rockets.
Performance: SPEED—695 mp CEILING—not available RANGE—not available.
Powerplant: TYPE—Verdon 350.
Deployment: Ordered by French an Indian Air Force

MIRAGE III-A

Type: Interceptor, fighter
Prime contractor: Dassault
Armament: Two MATRAS; two 3 mm. cannon; one 5103 or R53 missile; two 1000 lb. bombs.
Performance: SPEED—Mach 2. CEILING—more than 70,000 ft. RANGE—not available.
Powerplant: CONTRACTOR—SNECMA/SEPR. TYPE—Atar 9 and SEPR 84. NUMBER—one of each.
Deployment: French Air Force units.

SUPER MYSTERE B2

Type: Interceptor, fighter.
Prime contractor: Dassault.
Armament: Two R-511's or AA 10's, two 30 mm. cannon, 35-rocket pack.
Performance: SPEED—743 mph. CEILING—55,000 ft. RANGE—not available.
Powerplant: CONTRACTOR—SNECMA. TYPE—Atar 101G.
Deployment: Operational with French Air Force.

ISON

BEAR

Soviet Union

EAR TU-95

ype: Long-range heavy bomber.
esigner: Tupolev.
rmament: Possibly Komet D's or advanced models; paired 23 mm. cannon and one fixed cannon; HE or nuclear bombs.
erformance: SPEED—about 620 mph. CEILING—more than 36,000 ft. RANGE—4300 miles (with maximum load).
owerplant: DESIGNER—Kutsnetsov. TYPE—K turboprops. NUMBER—four.
eployment: Operational with DA, the Soviet Strategic Air Command.

ISON

ype: Long-range heavy bomber.
esigner: Ilyushin.
rmament: Possibly Komet D's or advanced models; one fixed and pair of 23 mm. cannon; HE or nuclear bombs.
erformance: SPEED—about 620 mph. CEILING—about 40,000 ft. RANGE—7000 miles (10,000 lb. bomb load), 3000 miles (20,000 lb. bomb load).
owerplant: DESIGNER—Mikulin-Zubets. TYPE—turbojets. NUMBER—four.
eployment: DA.

ADGER TU-16

ype: Long-range medium bomber.
esigner: Tupolev.
rmament: Possibly Komet D's or advanced models; paired 23 mm. cannon and one fixed 20 mm. cannon; HE or nuclear bombs.
Performance: SPEED—about 620 mph. CEILING—more than 40,000 ft. RANGE—more than 4000 miles.
Powerplant: DESIGNER—Mikulin-Zubets. TYPE—turbojets. NUMBER—two.
Deployment: DA.

BOUNDER

Type: Medium strategic bomber.
Armament: Komet D's or possibly advanced models; nuclear bombs.
Performance: SPEED—Mach 2. CEILING—about 60,000 ft. RANGE—not available.
Powerplant: TYPE—turbojets. NUMBER—four.
Remarks: The Russians are reported to have produced a small number of Bounders. The plane is reported to have been used as a test bed for nuclear aircraft powerplants as well as being deployed with DA. The Bounder is considered a Soviet counterpart to the U.S. B-58.

YAK-42 BACKFIN

Type: Fighter bomber.
Designer: Yakolev.
Armament: Six 105 mm. rockets; possibly M-100A's; 37 mm. tail cannon; nuclear or HE bombs.
Performance: SPEED—Mach 1.2. CEILING—more than 60,000 ft. RANGE—probably about 1500 miles.
Powerplant: TYPE—AM-3 turbojet. NUMBER—two.
Deployment: Soviet Air Force.
Remarks: The Backfin along with the IL-140 Blowlamp is reported to be replacing the subsonic IL-28 Beagle.

YAK-42 BACKFIN

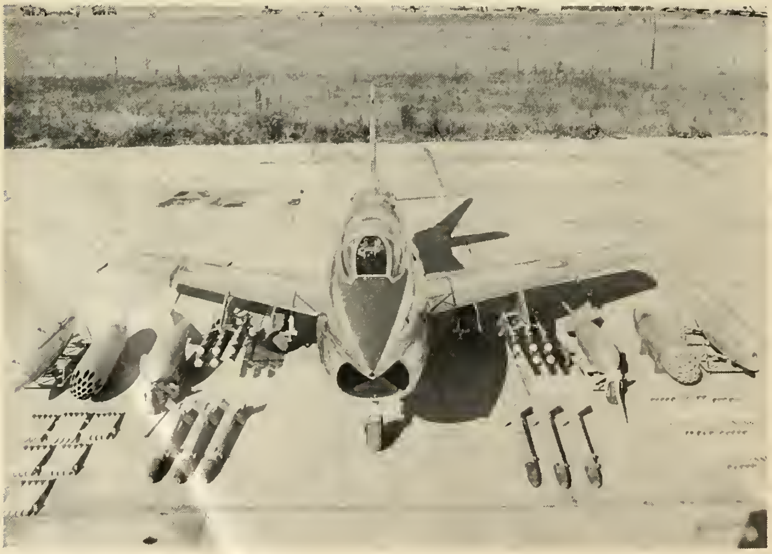
Courtesy of Aviation Magazine, Paris, France

Courtesy of Aviation Magazine, Paris, France

MIG-19 FARMER

Courtesy of Aviation Magazine, Paris, France

IL-28 BEAGLE



G.91

MOBILE MISSILE PLATFORM

MIG-19 FARMER

Type: Interceptor, fight

Designer: Mikoyan and Gurevi

Armament: 32 folding fin air-to-a rockets; probably M-100A's; o 37 mm. cannon; one 23 mm. ca non.

Performance: SPEED—about 9 mph. CEILING—58,000 RANGE—1000 miles.

Powerplant: DESIGNER—A. M Lyulka. TYPE—turbojets. NUM BER—two.

Deployment: Soviet intercepto squadrons; also Sino-Soviet Bl nations.

IL-28 BEAGLE

Type: Fighter bombe

Designer: Ilyushi

Armament: Possibly air-to-air, air-to surface missiles, in later version Reported to be capable of carr ing more than 6000 lbs. of bomb

Performance: SPEED—nearly 60 mph. maximum. CEILING—abo 40,000 ft. RANGE—about 150 miles.

Powerplant: TYPE—VK-1 turbojet NUMBER—two.

Deployment: Soviet Air Force. Als the Air Forces of many of th Soviet satellite nations and Re China.

Italy

G.91

Type: Fighter

Prime contractor: Fiat

Armament: 5103's, air-to-surfac rocket packs; 2000 lbs. of bombs

Performance: SPEED—675 mph CEILING—not available RANGE—350 miles.

Powerplant: CONTRACTOR—Bristol. TYPE—Orpheus 3.

Deployment: Italian Air Force

Sweden

A32A LANSEN

ype: Fighter.
rime contractor: Saab.
rmament: Sidewinders or Robot 304's, bombs, rockets.
erformance: SPEED—700 mph. CEILING—not available. RANGE—2000 miles.
owerplant: CONTRACTOR—SFA. TYPE—RM-5 (Avon).
eployment: Royal Swedish Air Force.

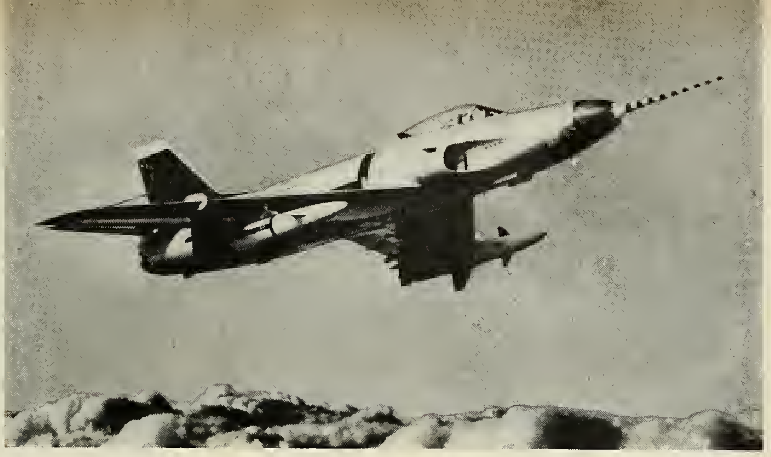
35A DRAKEN

ype: Fighter.
rime contractor: Saab.
rmament: Two to four Sidewinders; two 30 mm cannon.
erformance: SPEED—more than 990 mph. CEILING—55,000 ft. RANGE—not available.
owerplant: CONTRACTOR—SFA. TYPE—RM6 (Avon).
eployment: Royal Swedish Air Force.

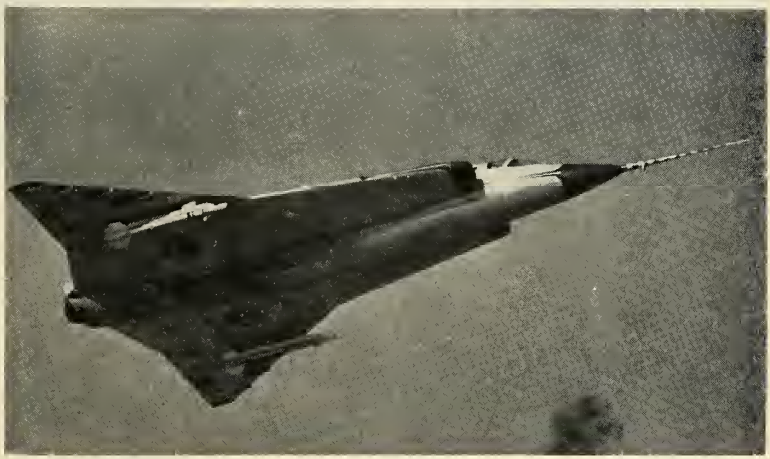
Switzerland

AMPIRE

ype: Trainer or fighter.
rime contractor: De Havilland of Great Britain.
rmament: Clusters of folding fin rockets; four 20 mm. cannon.
erformance: SPEED—more than 500 mph. CEILING—more than 40,000 ft. RANGE—more than 800 miles.
owerplant: CONTRACTOR—D. H. Goblin. TYPE—turbojet.
eployment: Many European, Asian and South American Air Forces; an advanced trainer in Great Britain.

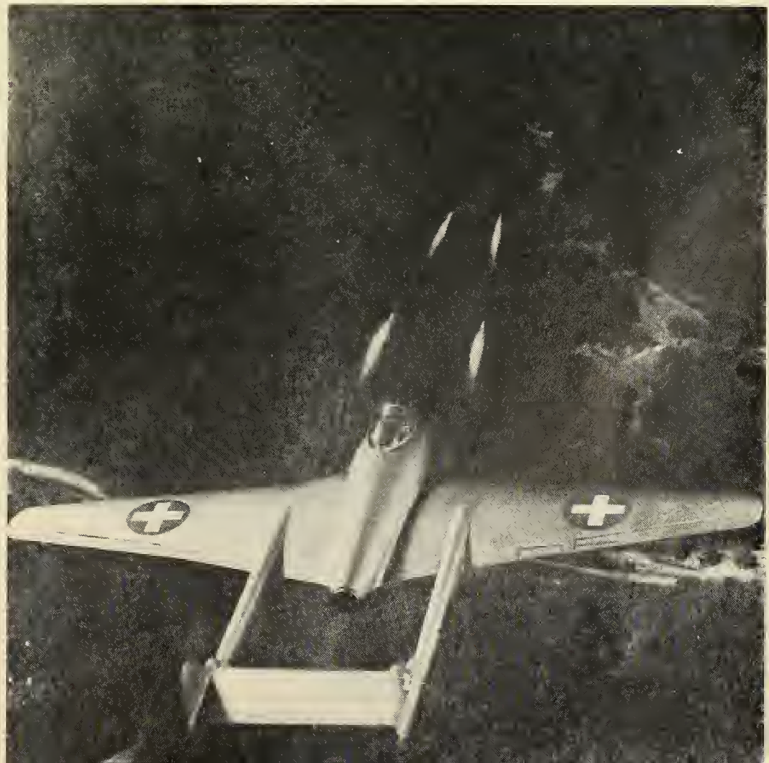


A32A LANSEN

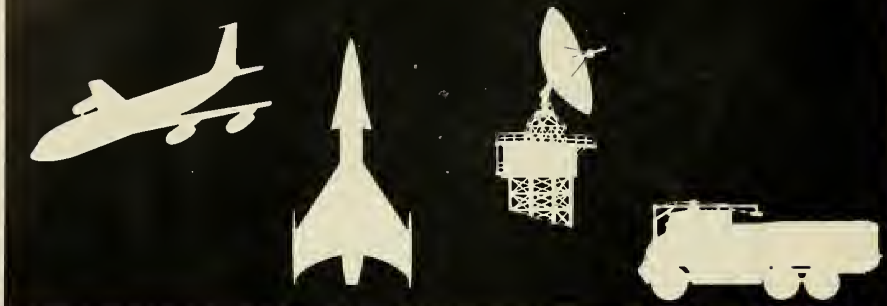


J35A DRAKEN

VAMPIRE



WHICH PICTURE FITS YOU BEST?



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Technical Countdown

PROPULSION

Discriminating Control Needed for Saturn

The biggest unsolved problem in *Saturn* is developing a reliable device that will stop a malperforming engine every time—but not stop a good engine. If one engine fails, fuel is diverted to the other seven and the guidance equipment makes compensating thrust-alignment changes to successfully continue the mission.

Near-Vacuum Startup Poses Problems

The problem of startup in near-vacuum conditions is still plaguing designers of upper-stage hydrogen-oxygen engines for *Centaur* and *Saturn*. The H-O propellant combination is harder to ignite than LOX-kerosene.

aturn Mating Schedule Changed

Only the first of each series of three *Saturn* vehicles will be mated at Huntsville before shipment to Canaveral. Previously, all ten vehicles in the development program were to come to Huntsville first.

ource Inspection to be Relaxed

The size of the *Saturn* program—much larger than any previously handled by Von Braun's Huntsville team—requires some relaxation of customary intensive in-factory supervision of component manufacture. But if quality falls, says *Saturn* boss Oswald Lange, a preferred list of vendors and fixed-fee contracts may be used.

ELECTRONICS

ig Future Seen for Electrostatic Gyro

Electrostatically supported gyros eventually will surpass conventional gyroscopes for missile use because of their precision, reliability, and small size and weight. General Electric's engineers made this prediction recently at the test labs of the company's Light Military Electronics Dept., after successful continuous operation of prototypes for over 100 hours. The frictionless units are expected to decrease gyro drift significantly.

eus Ground Computer To Be Tested

First *Nike-Zeus* target-intercept guidance computer has just been installed for test operation at the Army's White Sands Missile Range. Believed to be the fastest and most reliable ground-guidance computer developed to date, the prototype is continually self-checking and assists in fault isolation by module. Remington-Rand Univac and Bell Telephone Labs developed the system for the Ordnance Corps.

MEWS-Thule Operational

First Ballistic Missile Early Warning station at Thule, Greenland, went operational last week. Operational responsibility was transferred to NORAD by the AF Electronic Systems Center, Bedford, Mass. A second site at Clear, Alaska, is scheduled to be ready by next summer, and the last station, in Yorkshire, England, will follow. From initial intercept to local computer to central control and display at NORAD-Colorado Springs, total time required should be less than 10 seconds, the Air Force says.

Radiation-Resistant Solar Cell Developed

A radiation-resistant solar cell—called the most striking advancement since production of the first cell in 1954—has been developed by the Army Signal Corps. The new solar cells resemble current types except that they are made of p-type silicone crystals infused with phosphorus.

Space Power Requirements to Increase

The next few years will see a rapid increase in electrical power requirements for space missions, according to Dr. Ernst Stuhlinger of NASA. He predicted that in about ten years space missions will require continuous power outputs of 300-500 kw.

Miniature Nuclear Powerplant Being Developed

A nuclear powerplant no bigger than a watermelon is under development at General Electric. The compact unit will produce 5-30 kw of electricity for use in satellites and manned space vehicles. Thermionic cells are used to convert nuclear heat energy from pellets of uranium or plutonium directly to useful electrical power.

GROUND SUPPORT EQUIPMENT

Cape Survey Best Ever

The ground survey performed recently at Cape Canaveral for a new missile-tracking network achieved the greatest accuracy ever for any earth measurement, Error was less than 1/16 inch to a mile. The task was accomplished over a 4000-sq.-mile area encompassing nine new sites for tracking cameras. Coast and Geodetic Survey scientists who did the job bettered Air Force requirements by a factor of 2.5 in achieving an accuracy of better than 1 part in a million.

New Smear Camera Revealed

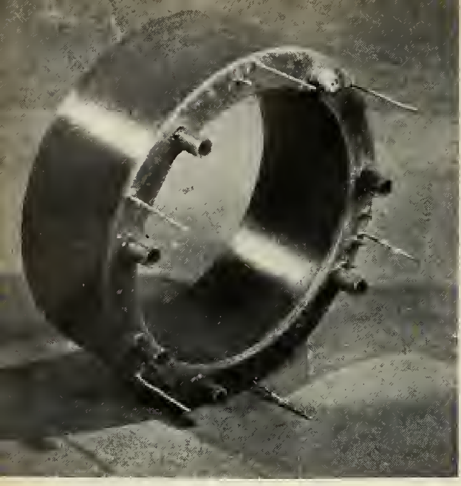
An ultrahigh-speed framing camera designed by Tsuneyoshi Uyemurra of Tokyo University permits continuous operation at 100,000 frames/sec. Two hundred exposures per run with a 1-usec exposure time are achieved using a 4-face rotating mirror. System will be described at 5th International Congress on High-Speed Photography in Washington, D.C. (Oct. 20).

Woomera DSIF Almost Complete

The second unit in the NASA/JPL world-wide deep-space instrumentation facility (DSIF) is duc to go into operation at Woomera, Australia, by Nov. 1. The 85-ft. tracking antenna is complete and last units of electronic equipment are being installed. A third site, at Krugersdorp, South Africa, is due for completion next year.

Decision on Saturn Pad Delayed

No final decision has been made on whether a third *Saturn* launch complex—included in NASA construction plans for Canaveral—will actually be built. At Pt. Arguello, meanwhile, the space agency plans to build a central headquarters office to house about 35 administrative workers, a telemetry building, and a central storage and issue building.



COMPLETED unit formed into ring and encapsulated. Matrix can be wound or bent.

Automated Output Of Circuits Approaches

GE's welded-wire matrix is key to new process for tape-controlled fabrication

by Hal Gettings

UTICA, N.Y.—Completely automatic production of electronic circuits—from design to final test—may not be too far in the future. Some of the necessary machines are already available commercially. Others are being built. And the remainder appear feasible to engineers working on the problem.

General Electric (Light Military Electronics Dept.) this month put into operation one of the major elements of an automated system. This is a computer-controlled fabrication machine that can turn out 30 feet of welded-wire circuit matrix per hour. With the computer/machine combination, a breadboard matrix can be produced in something like 90 minutes—as compared to days for a printed-wiring breadboard.

GE feels that the welded-wire matrix (or WWM) lends itself to automated manufacturing better than any other similar method. For example, the layout of printed-wiring boards by computer is complicated by crossover problems. The matrix has unlimited crossover possibilities. In addition, it offers advantages in size reduction, reliability, ruggedness, and flexibility. It is adaptable to microminiaturized components and solid-state circuits.

• **WWM not new**—The matrix idea is not really new. An original patent was granted in 1934 but, so far as is known, was never applied. Samuel A. Francis, of Francis Associates, received a patent on certain variations of the matrix design in 1959, and his company used the technique in construction of prototype *Polaris* guidance computers. GE is presently using matrix circuitry in production models of the *Polaris* computer and for other applications, and has applied for patents on new methods of construction.

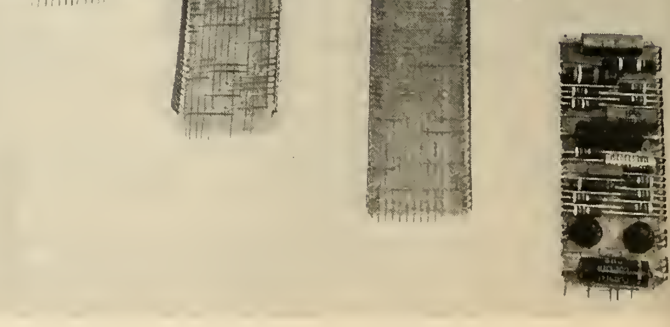
The welded-wire matrix is composed of two layers of parallel wires separated by a thin insulating sheet. One layer of wires runs lengthwise and the other transverse to the matrix ribbon. Grid increments may be as small as 0.05-in.

Interconnections between wires in the two layers are made by welding at desired intersection points. Insulation at these points is burned away by the welding heat. Components can be welded directly to the matrix wires or welded (or soldered) to terminal strips along the sides of the matrix ribbon.

• **Computer design next step** —Computer design and machine fabrication are only now being applied. Although a completely automatic production line is still some time off, GE is approaching this goal. Its just-completed fabrication machine can produce both breadboard and production qua tities of the matrix ribbon. The only maining elements to be built are a co ponent placing machine and an au matic tester.

In production operation, inform tion from a schematic is prepar by engineering on a form specified standards, and sent to the compu group. This information will be punch into a paper tape which is fed to a co puter. Operating on a program suitab for all circuits, the computer will l out the matrix, taking full account the size of components, lead locatio required electrical connections, critic nodes (or junction points) and oth considerations.

(As an example of the speed of c eration of the computer, an electron circuit containing 79 components w reduced to matrix form in nine minut



CONSTRUCTION BEGINS with welding interconnections between horizontal a vertical wires (left). Unwanted wires are clipped, insulation applied, and parts soldere f computer time. Of the nine minutes, ne was required to feed the tape into he computer, three to lay out and wire p the matrix, and five to punch the utput tape.)

The output tape is fed to a printer, hich in 15 minutes produces a sheet howing the location of components in roper staggered positions and the interonnection pattern for the matrix. The me for print-out can be reduced to ss than five minutes when a mag-tape ystem and a high speed printer are vailable.

- **Simple languages**—The printed heet provides a visual picture of the atrix layout. A repetition of dashes epresents transverse wires; repeated gure one (1) represents longitudinal ires. The character X designates weld oints. Components and node symbols re listed at the left of the sheet. After spection, changes in the layout may e made by an editorial routine availble to instruct the computer to make he change.

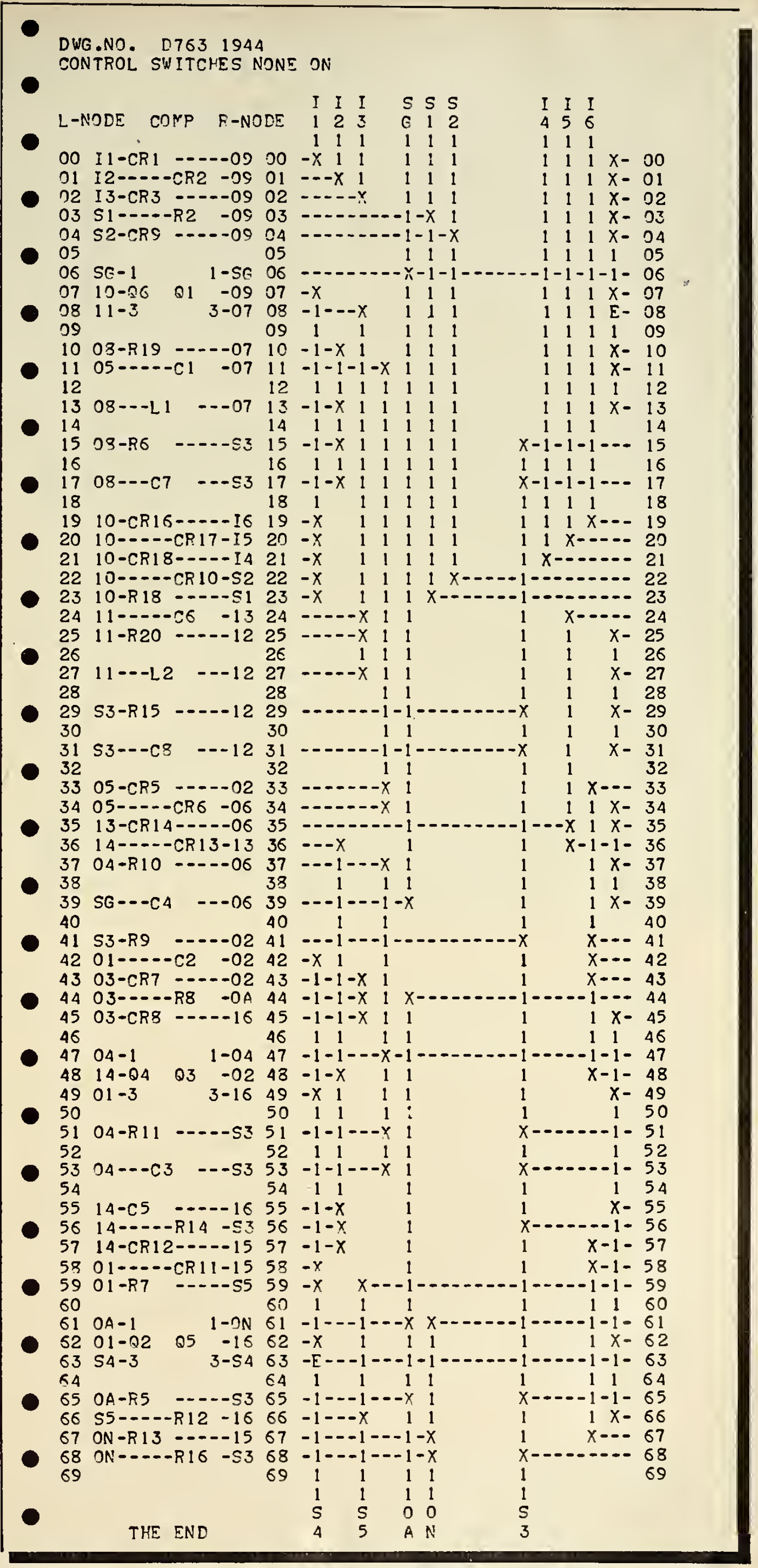
The paper tape output of the comuter can be fed to a translator to prouce a number of specialized tapes. ne tape controls a drafting machine hich produces drawings of the matrix r the customer. Another controls the brication machine which welds the terconnections.

Superfluous wiring in the matrix is tomatically cut out by the fabrication achine. Components are soldered (or elded) in place by a technician acrding to the computer tape diagram. he completed circuit can be encaplated, mounted on metal or plastic ates, or incorporated in other ciritry.

- **Configuration changed easily**—ne automatic fabrication machine is signed to fabricate any matrix from e to fourteen longitudinal wires wide th a minimum of setup time. Within given width, only the punched paper ntrol tape need be changed to obtain different circuit configuration.

Substantial lengths of wire and inlating sheet are carried on reels in e machine, making individual mates of extended lengths possible. By rming the control tape in a loop the achine can be made to repeat one atrix configuration to produce a antity of identical assemblies.

- **Resistance welding?**—GE will rese no information on the type of lding used, other than to say that new. Resistance welding has been d in other cases and it's assumed that s or some variation of it is probably basis of the GE method. The comny has developed a special welding ntrol for use with the machine which ovides the necessary fast recovery e and pulse precision. Monitoring ntrols are also being developed to



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DWG.NO.  D763 1944
CONTROL SWITCHES NONE ON

                      I I I   S S S       I I I
L-NODE  COMP  R-NODE  1 2 3   G 1 2       4 5 6
                      1 1 1   1 1 1       1 1 1
00 I1-CR1 -----09 00 -X 1 1   1 1 1       1 1 1 X- 00
01 I2-----CR2 -09 01 ---X 1   1 1 1       1 1 1 X- 01
02 I3-CR3 -----09 02 -----X   1 1 1       1 1 1 X- 02
03 S1-----R2  -09 03 ---------1-X 1       1 1 1 X- 03
04 S2-CR9 -----09 04 ---------1-1-X       1 1 1 X- 04
05                05          1 1 1       1 1 1 1  05
06 SG-1      1-SG 06 ---------X-1-1-------1-1-1-1- 06
07 10-Q6  Q1  -09 07 -X       1 1 1       1 1 1 X- 07
08 11-3      3-07 08 -1---X   1 1 1       1 1 1 E- 08
09                09  1   1   1 1 1       1 1 1 1  09
10 08-R19 -----07 10 -1-X 1   1 1 1       1 1 1 X- 10
11 05-----C1  -07 11 -1-1-1-X 1 1 1       1 1 1 X- 11
12                12  1 1 1 1 1 1 1       1 1 1 1  12
13 08---L1  ---07 13 -1-X 1 1 1 1 1       1 1 1 X- 13
14                14  1 1 1 1 1 1 1       1 1 1    14
15 08-R6  -----S3 15 -1-X 1 1 1 1 1     X-1-1-1--- 15
16                16  1 1 1 1 1 1 1     1 1 1 1    16
17 08---C7  ---S3 17 -1-X 1 1 1 1 1     X-1-1-1--- 17
18                18  1   1 1 1 1 1     1 1 1 1    18
19 10-CR16-----I6 19 -X   1 1 1 1 1     1 1 1 X--- 19
20 10-----CR17-I5 20 -X   1 1 1 1 1     1 1 X----- 20
21 10-CR18-----I4 21 -X   1 1 1 1 1     1 X------- 21
22 10-----CR10-S2 22 -X   1 1 1 1 X-----1--------- 22
23 10-R18 -----S1 23 -X   1 1 1 X-------1--------- 23
24 11-----C6  -13 24 -----X 1 1         1   X----- 24
25 11-R20 -----12 25 -----X 1 1         1   1   X- 25
26                26      1 1 1         1   1   1  26
27 11---L2  ---12 27 -----X 1 1         1   1   X- 27
28                28        1 1         1   1   1  28
29 S3-R15 -----12 29 -------1-1---------X   1   X- 29
30                30        1 1         1   1   1  30
31 S3---C8  ---12 31 -------1-1---------X   1   X- 31
32                32        1 1         1   1      32
33 05-CR5 -----02 33 -------X 1         1   1 X--- 33
34 05-----CR6 -06 34 -------X 1         1   1 1 X- 34
35 13-CR14-----06 35 ---------1---------1---X 1 X- 35
36 14-----CR13-13 36 ---X     1         1   X-1-1- 36
37 04-R10 -----06 37 ---1---X 1         1     1 X- 37
38                38    1   1 1         1     1 1  38
39 SG---C4  ---06 39 ---1---1-X         1     1 X- 39
40                40    1   1           1     1    40
41 S3-R9  -----02 41 ---1---1-----------X     X--- 41
42 01-----C2  -02 42 -X 1   1           1     X--- 42
43 03-CR7 -----02 43 -1-1-X 1           1     X--- 43
44 03-----R8  -0A 44 -1-1-X 1 X---------1-----1--- 44
45 03-CR8 -----16 45 -1-1-X 1 1         1     1 X- 45
46                46  1 1   1 1         1     1 1  46
47 04-1      1-04 47 -1-1---X-1---------1-----1-1- 47
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51 04-R11 -----S3 51 -1-1---X 1         X-------1- 51
52                52  1 1   1 1         1       1  52
53 04---C3  ---S3 53 -1-1---X 1         X-------1- 53
54                54  1 1     1         1       1  54
55 14-C5  -----16 55 -1-X     1         1       X- 55
56 14-----R14 -S3 56 -1-X     1         X-------1- 56
57 14-CR12-----15 57 -1-X     1         1     X-1- 57
58 01-----CR11-15 58 -X       1         1     X-1- 58
59 01-R7  -----S5 59 -X   X---1---------1-----1-1- 59
60                60  1   1   1         1     1 1  60
61 0A-1      1-0N 61 -1---1---X X-------1-----1-1- 61
62 01-Q2  Q5  -16 62 -X   1   1 1       1     1 X- 62
63 S4-3      3-S4 63 -E---1---1-1-------1-----1-1- 63
64                64  1   1   1 1       1     1 1  64
65 0A-R5  -----S3 65 -1---1---X 1       X-----1-1- 65
66 S5-----R12 -16 66 -1---X   1 1       1     1 X- 66
67 0N-R13 -----15 67 -1---1---1-X       1     X--- 67
68 0N-----R16 -S3 68 -1---1---1-X       X--------- 68
69                69  1   1   1 1       1          69
                      1   1   1 1       1
                      S   S   0 0       S
      THE END         4   5   A N       3
```

COMPUTER LAYOUT TAPE shows physical layout. Left columns show component positions relative to numbered terminal strip. Diagram at right shows interconnection pattern. X marks indicate welds.

insure a high degree of reliability in the finished product.

Considerable research has been done by GE on welding techniques and the compatibility of components leads with this type of connection. A survey was made of component suppliers to determine most widely used materials, coatings, and other characteristics of leads. Samples were tested and a variety of welding machines evaluated. Thousands of test-joints were welded and pulled to destruction to obtain optimum settings.

Test results have provided an intermediate material with a composition and a configuration compatible with all components leads normally encountered. GE engineers see as the next step the development of lead materials specifically suited for the welding process.

ISA Meet Shows Interest In Underseas, Meteorology

New York—The prevailing trend of more and bigger advances in missile/space hardware, evident at all technical exhibits these days, continued at the 15th annual Instrument Society of America show held here recently.

But it failed to dominate the more traditional pneumatic, hydraulic, chemical and electrical instrumentations displayed for all of the other technological areas.

The conference papers, however, reflected the growing interest of the ISA in two expanding fields: underwater and meteorological instrumentation. A special panel session on "Automatic Landings on Earth and Planets" further demonstrated the effects of th missile/space age.

Some 30,000 persons were expected to view the more than 300 exhibits a the Coliseum during the five-day meeting. By mid-week, however it appeared that this figure was highly optimistic—registrations still numbered less than 18,000.

• **New advances described**—To better understand rapid changes in quality of underwater sound transmission, a field meter for continuous deep water measurement of sound velocity, depth (pressure) and water temperature has been developed and tested successfully.

Described in a paper by J. R. Lovett and S. H. Sessions of the Naval Ordnance Test Station, China Lake, the instrument is housed in a 70-lb. stainless steel cylinder, two feet long by six inches in diameter. It includes a tiny transceiver, a pair of thermistors and a vibrating wire pressure transducer. Rechargeable nickel-cad batteries permit eight-hour operation. Three multiplexed FM channels are transmitted through the single suspension cable, and sea water serves as return conductor.

Optron Corp. has developed a special electron tube, the Model 650, that is part of an optical device used to measure motion, vibration or displacement of an object. Used with an auxiliary telescope, it could serve for automatic control of tracking cinetheodolites. With a 40-in. focal length scope, tracking accuracies of ±10 sec. are possible with a resolution of .05 milliradian in a 10-milliradian field of view.

Statham Instruments, Inc., introduced a dime-size diaphragm absolute pressure transducer. For missile use, the tiny sensor features high-frequency response; ranges are 0-10 psia to 0-100 psia. Size is 0.590-in.-dia. by 0.050-in.-thick.

Electro-Optical Systems, Inc., described its new silicon whiskers used to provide 50 to 60 times more sensitivity than conventional transducers. One inch long by 0.5 mil dia., the whiskers are formed by etching or vapor deposition techniques. Called a Micro-sensor, the device manifests a piezoresistive effect when strained and provides a gage factor of nearly 130, compared to five for transducers of metallic construction.

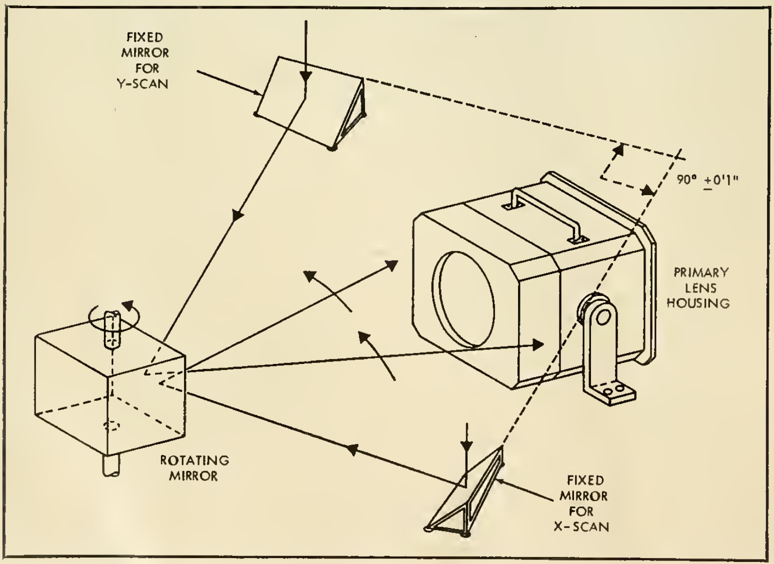
Instrument Development Laboratories, Inc., introduced its new Pyro-eye, an automatic two-color pyrometer. It

Contract Let for Real-Time Tracker

The Air Force has awarded Radiation Inc. a contract for development of the design for a "real time" missile tracking system. Announcement of the award confirms an earlier report in M/R (Aug. 22, p. 27).

To be known as SORTI (Star-Oriented Real-Time Tracking Instrument) the tracker will be the first to combine the high accuracy of the ballistic camera system with a real-time position tracking system, according to the company. This combination will provide immediate, accurate information, during flight, about a missile's path, and could make possible immediate analysis and possible in-flight corrections of the missile's trajectory.

The real-time position tracking system will utilize star positions for orientation reference. By incorporating electronic circuitry, SORTI will provide a method of overcoming present handicaps in trajectory tracking. It will retain the best features of the ballistic camera system.



CONCEPT FOR the SORTI instrument under development by Radiation Inc. is shown schematically. In the focal plane of a ballistic camera lens is a narrow slit with a photomultiplier detector tube behind it. A rotating mirror scans the sky alternately in x- and y-directions. A clock tied to the mirror rotation counts increments of angular measurement and its output is gated by the detector tube so as to provide an accurate reading of the angular displacement between two celestial light sources such as a missile and a known star.

Crib Mount Shields Atlas from Shock

Convair finds that the technique gives highest possible reliability against nuclear-weapon ground vibration

by George S. Rasmussen*

ISOLATING MISSILE systems om nuclear-weapon ground shock is ne of the most important problems in e field of shock and vibration. The eed for practical solution is immediate.

To provide a high degree of isolaon from ground shock. low-frequency ock-mounting techniques with small ttle space must be developed. There e relatively few installations that can pply a very-low-frequency system for large suspended mass.

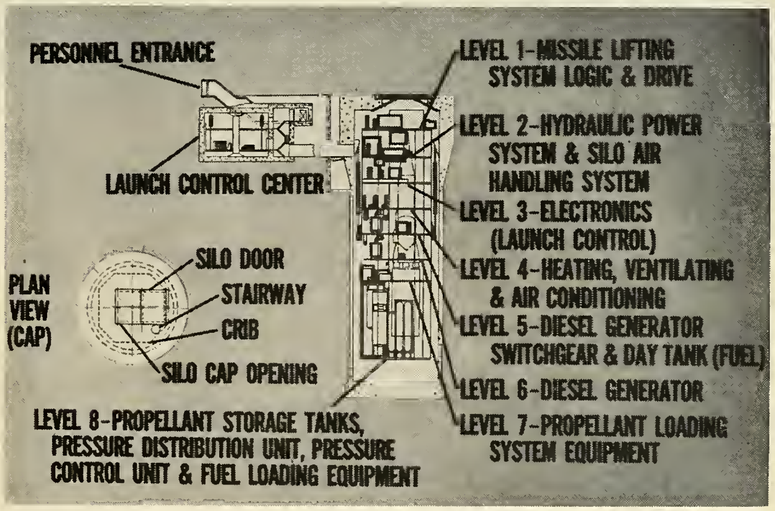
The effect of the various shock olation methods on total facility cost ould be carefully weighed. If the best ailable method is used. the cost of ock isolation for a hardened system ould be substantially less than 10% total facility cost.

Whatever method is chosen, high liability is essential: if only one out 10 sites fails to accomplish a launch cause of ineffective shock mounting, proves that more money should have en spent for reliable isolation.

• **Best system**—A suspended crib ovides the ultimate isolation for the tire weapon system. In such designs, e only connecting link is between the ockhouse and the missile/GSE enosure.

Thus, all equipment can be rigidly ached to the crib structure and need t be designed to withstand high rtial loads. Only the rattle space of crib itself has to be considered. Rebility is as high as can be attained the shock environment.

Since the missile can be stored on same crib as the GSE, only one closure is required. See the accomying diagrams showing silo arrangents for *Atlas*. Since the personnel in launch control center are on the ne platform as the equipment, the ration level can be reduced so that y require no further protection.


PERSONNEL ENTRANCE
LAUNCH CONTROL CENTER
PLAN VIEW (CAP)
SILO DOOR
STAIRWAY
CRIB
SILO CAP OPENING
LEVEL 8-PROPELLANT STORAGE TANKS, PRESSURE DISTRIBUTION UNIT, PRESSURE CONTROL UNIT & FUEL LOADING EQUIPMENT
LEVEL 1-MISSILE LIFTING SYSTEM LOGIC & DRIVE
LEVEL 2-HYDRAULIC POWER SYSTEM & SILO AIR HANDLING SYSTEM
LEVEL 3-ELECTRONICS (LAUNCH CONTROL)
LEVEL 4-HEATING, VENTILATING & AIR CONDITIONING
LEVEL 5-DIESEL GENERATOR SWITCHGEAR & DAY TANK (FUEL)
LEVEL 6-DIESEL GENERATOR
LEVEL 7-PROPELLANT LOADING SYSTEM EQUIPMENT

ATLAS UNITARY launch facility shown in a cutaway view.

In the *Atlas* unitary silo, each shock strut contains seven spring cells in which there is a spring within a spring within a spring. Eliminating one or several springs permits locating the elastic center of the spring hangers at any point within 40 inches of the geometric center. Thus, the elastic center can be placed close to the c.g. to reduce the pitch response to vertical shock. These spring hangers are about 50 feet long and provide a lateral rigid-body vibration frequency of approximately 0.13 cps.

This ultimate isolation does not come without certain disadvantages: The suspended mass may be tremendously large. The cost of a low-frequency mounting system for such a mass will increase significantly if the rigid-body vertical vibration frequency drops well below 1 cps.

The reason for the cost increase is that a low maintenance steel-spring system is not feasible for very-low-frequency applications; a hydraulic-pneumatic or some other similarly complex isolation system must be employed. Furthermore, a large rattle space is required for the low-frequency crib motion. However, floor space is less than that needed for palletization and individual shock-mounting.

The additional fabrication cost required for the crib may be balanced by the saving in the cost of equipment (no necessity for rugged equipment) and by the reduction in the construction cost of the enclosure.

Limited design experience is the major problem with a shock-isolated crib. The design and fabrication of the crib and shock-mount structure must be closely controlled to make sure that the elastic response of the crib will be negligible and the desired rigid-body vibration characteristics attained.

• **Designing against shock**—A number of factors enter into the choice of a method of shock isolation. Primary is the severity of the shock environment.

For severe ground shocks, palletization and crib mounting are more desirable than shock-mounting individual items of equipment.

Many GSE items are designed to withstand not more than normal handling shocks; this is especially true for electronic equipment. Rapid-fill propellant loading systems are quite vul-

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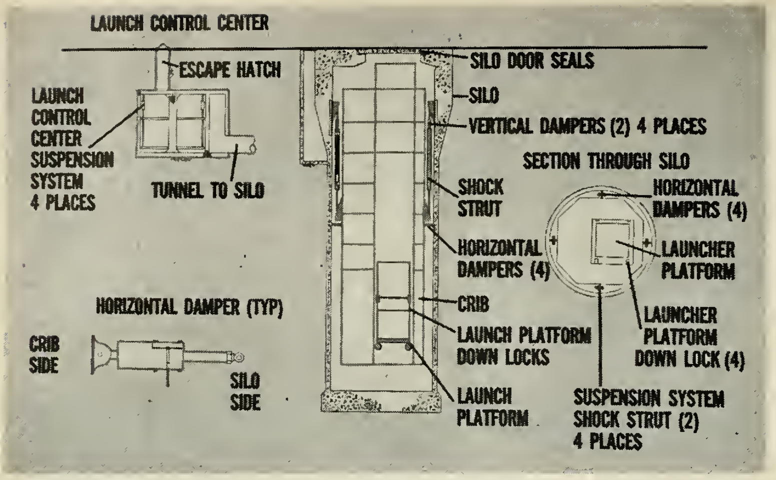
Senior Research Engineer, Convair (tronautics) Div., General Dynamics p., San Diego.



SUSPENSION SYSTEM shows struts and horizontal dampers for isolating Atlas crib.

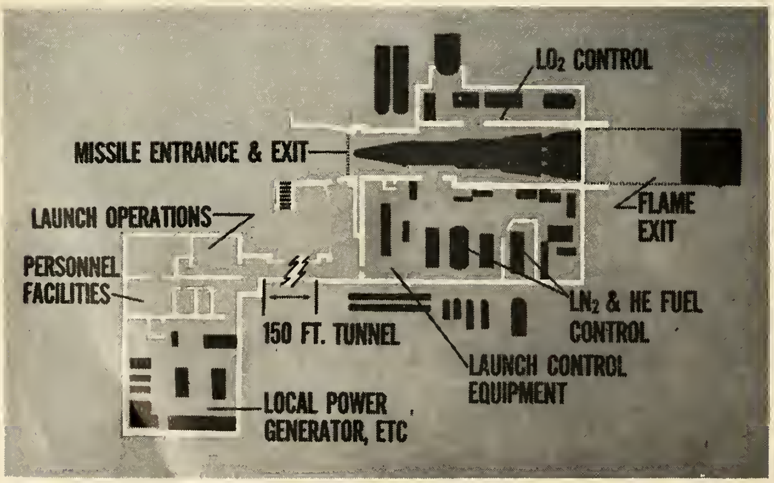
nerable to damage by ground shock. The electronic equipment and valves are fragile, and the long spans and bends of piping cannot withstand high inertial loads. High electronic cabinets can overturn or have electrical connections loosened as a result of a severe shock.

In general, shock-mounting individual items of equipment should be done only when the majority of the equipment is capable of withstanding the shock with standard mounts and mounting procedures. It is quite possible, however, that a combination of palletization and mounting of individual items could prove best for moderate environments.

For sites with horizontal missile storage, the best design approach appears to be complete isolation of the missile and its erection boom from the walls and floor of the shelter. Since the boom represents a flexible beam, dynamic deflections of the boom during ground shock may cause significant bending moments in the missile. Isolation of the boom and missile on the same mounting system can reduce the elastic deflection of both, and hence, the bending moments.

Sites with vertical missile storage require an isolated crib to protect the missile. If in-silo launch is not used, an elevator must be provided within the crib to bring the missile to the surface for launching. The flexibility of the crib should be considered; however, if the frequency of the fundamental mode of vibration is sufficiently high the assumption of a rigid crib can be justified. For flyout launch platforms this would certainly be the case.

It is expected that the critical shock and vibration environments to be used for the design of missile systems of the future will be those peculiar to the mobile carrier—ship, barge, railroad train, truck, trailer, etc.—in normal operation. ⁂



LAYOUT OF a coffin configuration for the Atlas.

Hound Dog Loading Tim Slashed with New Facilit

A new facility for loading *Hou*
Dog missiles has sharply reduced shi
ping time at North American Aviatio
Missile Division, Downey, Calif.

Wide enough to accommodate thr
trucks and 85 feet long, the loadi
facility is equipped with three m
chanical dock levelers which aut
matically adjust to the height of t
truck bed.

"We are saving at least a half-ho
in loading each missile that we sh
out," says Dale Haw, assistant traf
foreman at the Missile Division. Pr
viously, he explained, the missiles h
to be transported to the Autoneti
Division for loading onto trucks fro
an above-ground cement ramp wi
the air of a winch.

"Now, three men can load the mi
sile on the truck easily within fi
minutes," Haw says.

UE, SAAB Sign Contract For Swedish Range GSE

United Electrodynamics, Inc., Pas
dena, has signed a contract with Sw
den's SAAB Aircraft Co. under whi
the U.S. Firm will engineer and i
stall ground telemetry equipment f
a new Swedish missile range.

The cooperative agreement w
support SAAB's program to devel
a new air-to-air, air-to-ground missi
somewhat similar in purpose to t
U.S. *Sidewinder.*

Canadian RCA Firm Builds Detection System Circuits

Radio Corp. of America will shi
an increasing amount of its defen
business to its Canadian associate, RC
Victor Co., Ltd., President John
Burns has told a Toronto audience.

The Canadian company has alrea
taken on a $2-million order for equi
ment for an electronic detection a
control system, part of the Nor
American air defense.

The system involves the automat
transmission of information to *Boma*
missiles and interceptor planes. T
Canadian company will supply t
security sealed circuits. They are co
pact, prefabricated panels with the wi
ing permanently etched in place, whi
have largely supplanted bulky, han
soldered wiring in both military equi
ment and commercial electronics.

Mr. Burns noted that "as defen
and space electronics has become mo
and more important, and as our U.
defense business has grown, we ha
increasingly drawn our Canadian faci
ities into both the development and t
production phases of this work."

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Puzzler: the 'Atmosphere' of Space

Study at Ohio State underlines dearth of data on how the space environment will treat materials; simulation is extremely difficult

THE SEVERE LIMITS of this country's knowledge in dealing with the "atmosphere" of space have been revealed in a study sponsored by the Ohio State University Research Foundation.

The project was executed by a group of scientists at National Research Corporation, Cambridge, Mass.; the basic contracting party was Materials Central, Wright Air Development Division, Wright-Patterson AFB.

The 67-page report concerned itself with the effects of the space environment on materials and pointed up a startling lack of existing fundamental knowledge.

Admittedly, no dire effects are realized when short-term, or relatively simple satellites are operating in space. But with the increasing emphasis on development of manned stations and complex probes, a more appreciative effort should be made to understand this hostile environment in relation to our demands on materials.

Some of the conclusions of the report are presented briefly here.

• **Nothingness on Earth**—The most comprehensive section of the study deals with the current status of vacuum technology—with respect to the problems in simulating the space environment and the types of demands that are made on vacuum pumping and measuring equipment.

Space is considerably more complex than it seems at first. The rarified gas environment that would surround a stationary vehicle is a low-density mixture consisting primarily of hydrogen and helium—and the gas molecular motion would be substantially random or isotropic.

Further, the temperature of these gases will not be the same because of infrequent collisions, and equilibrium may not be attained because of the competing radiative processes of energy transfer.

Also, there may be directed gas flows emanating from the sun superimposed on the random gas motion.

A vehicle could not remain stationary at a single point in space because of the presence of the gravitational fields of the sun and earth. The effect of the velocity of the vehicle relative to that of its surrounding environment must be added.

Another complication is that the vehicle itself is a source of gas. Molecules leaving the surface will travel directly away from it, with negligible chance of collision and return to the surface.

These molecules will have superimposed on them the translational velocity of the vehicle at the instant they are evolved.

• **Understanding the case**—The problem of simulation is obviously complex. Total simulation would be prohibitively expensive, even if it could be done. Usually, simulations are concerned only with studying specific effects and each situation determines the vacuum requirements.

The report points out that the capability of producing vacuums down to 10^{-9} mm Hg exists today. In the achievement of lower ultimate pressures, the limitations which must be overcome are substantially those which have been of primary concern in developing ultrahigh vacuum to its current state. These are relatively straightforward.

One area of major deficiency in current vacuum technology, insofar as ultrahigh vacuum suitability is concerned, is that of seals and feedthroughs.

In the process of bringing a chamber down to the desired pressure level, a certain amount of "baking" is necessary. To remain tight in the face of thermal cycling, thermal gradients, reasonable mechanical tolerances, warping due to stress annealing and the stress of mechanical closures gasket materials must be capable of being highly strained without exceeding the elastic limit. The construction of moderate-size seals has lead to the usage of rubber and other elastomers. The outgassing rates of these materials render them unsuitable for the extreme ultrahigh vacuum range.

This is illustrative of the complications in the other aspects of reaching pressure below the current state of th art.

As bad as it is, the vacuum effec of space cannot be considered by itsel As usual, nature refuses to be simpl and tosses several other ingredients int the "normal" space environment.

• **Possibly synergistic?**—The stud states that another of the major prob lems in space simulation is the confine effect of radiation and high vacuum o the characteristics of polymeric an oxide coatings. Information on this i almost non-existent in the 10^{-9} mr Hg range—the pressure of space.

Radiation—induced changes will b mainly due to ionization and excitatio processes, because of the energy spec trum of the major constituent of spac radiation.

These effects are generally propor tional to the total energy absorbed b the materials regardless of the type o quality of radiation. In addition, th major proportion of the energy is ab sorbed in the outer skin. This las factor should make possible space i radiation simulation using a low-energ electron beam (300 kev and down) i a high-vacuum environment. High energy beams will not simulate a closely because their influence on bul effects would be greater than that ex pected of the real thing.

Such simulation should be in th 10^{-9} mm Hg range or lower and specia consideration will have to be given t the outgassing problems enhanced b radiation degradation.

The report points out that whil simulation is possible, it is not withi the current state of knowledge to equat it exactly to a given lifetime. Con tinuing satellite and rocket experiment may resolve this problem.

The authors realize that there is wealth of information on radiation ef fects—but the vacuum contribution ha been practically ignored. The few dat that are available caution that radia tion effects observed in air, especiall with organic materials, are not neces sarily transposable to those effect which would be found in a vacuum.

• **Earth's envelope**—The vast ma

jority of available data on the mechanical properties of materials was collected with little or no regard to the surrounding gaseous atmosphere or its pressure.

It is only in recent years that investigators have delved into these properties in the presence of a vacuum. As far as metals are concerned, the study concludes that the amount by which environments can effect their strength by altering the surface tension of a crack free surface is negligible except for the cases of very fine wires or extremely thin sheets.

The authors found that much of the data in the literature, especially in alloys, shows effects of environment directly attributable to gross composition or structure changes caused by diffusion of some element either into or out of, the specimen.

The large ratios reported for fatigue ife in vacuum to that in air and other ases may become considerably larger vhen the tests are performed in ultraigh vacuums. The present results have een termed "astounding."

Another conclusion is the possiility that the growth of solid oxide in urface cracks is responsible for the elatively small effect of environment n rupture life and creep rate of nickel nd nickel alloy rods.

The activity in vacuum mechanical esting included work accomplished at IIT, Naval Research Laboratories, J.S. Steel Corp. and National Research orp. Progress in France and Britain is lso mentioned.

A number of interesting conclusions re drawn from the field of highacuum friction.

In this area, the most important echanism is permitting really clean etal-to-metal contact and subsequent old welding. Lubrication thus becomes factor.

The authors approached the probm from the physico-chemical barrier pect to avoid confusion, since a numr of mechanisms are involved in dinary friction and wear processes. ne one main theme in all of these is eir dependence on some sort of ysico-chemical means of inhibiting e welding between the microscopic perities of relatively moving surfaces.

Bringing space into the picture adds few more variables. The effects of ction must take into account the ngth of the mission, duration and dee of high-temperature exposure, diation exposure and the dangers of ntamination by condensation.

Some of the other points mentioned lude:

-That low vapor pressure greases e available for use in vacuums up to mm Hg.

-That dry films have been successful in lightly loaded anti-friction bearings at speeds up to 7000 rpm.

-That all of the information on vacuum lubrication has been gleaned from vacuum environments with pressures higher than 10^{-9} mm Hg. It is only below this pressure that surfaces stay "clean" for hours instead of minutes or seconds.

Very little is being done on gear lubrication, although this presents even more difficulty than many bearings. The only activity known to the authors, outside of a small project at National Research, is a series of tests run by Southwest Research Institute for WADC. These involved a full-scale rig under various inert gas atmospheres to simulate the absence of oxygen.

In the electrical and electronic properties of materials, knowledge of the effect of the real, or simulated, space environment is relatively poor.

Surface conductivity, spectral emissivity, photoelectric emission and optical transmission are all strongly surface-dependent properties.

Every physical component made on earth has a thin surface layer completely covering the bulk material of which it is made. To the extent to which these surface layers are easily removed (10^{-6} mm Hg at moderate temperatures) the effects have been explored somewhat, particularly in the areas of surface electrical conductivity, high voltage breakdown and radiant heat transfer.

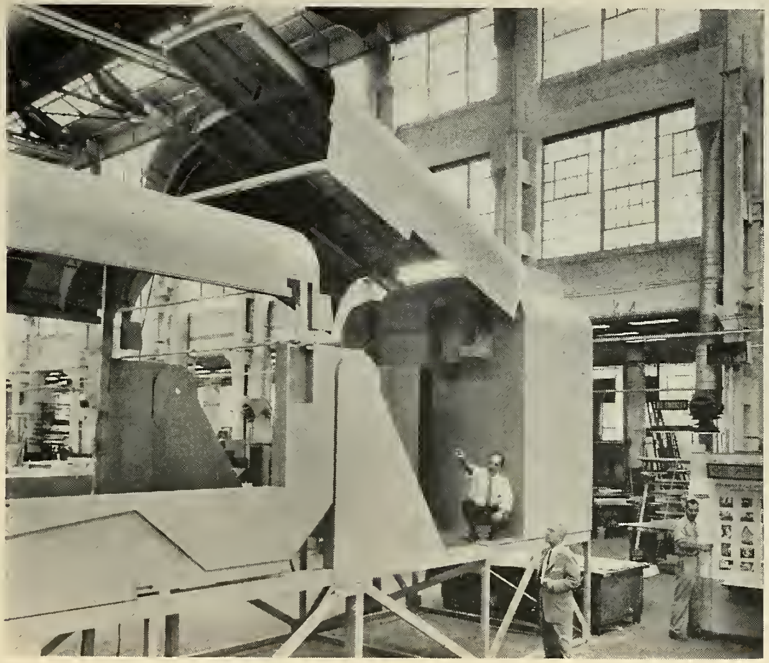
But practically none of this work has been concerned with the effect of vacuum as a variable. And less has been done in the study of ultra clean surfaces.

This is primarily due to the difficulty of providing an ultra-high vacuum in combination with radiation. The work that has been done was directed to ends other than the space environment, such as refractory filaments.

The effect of lack of gravity is mentioned only in passing, since there is no reason to assume that materials per se will be affected.

Meteoroids appear now not to offer any serious obstacles to the development of space vehicles, since adequate shielding may be achieved without punitive weight.

The study indicates that such things as the theoretical aspect of impact and a continuation of efforts to establish more rational state equations connecting stress, strain, temperature and strain rate for use in these studies. ⁂



Full-scale Minuteman Model

THIS WORKING-MODEL MOCKUP of the Minuteman railroad erector-launcher is expected to save considerable time and money in development of the operational carrier for the mobile ICBM. American Machine and Foundry, prime contractor for the train, says the three-dimensional full-scale model will give design engineers a much more realistic feel for the problems involved in the construction of this unique mobile launch pad. A commercial exhibit and display manufacturer—Ivel Construction Co., of New York—produced the 40-ft.-long, manually operated wooden mock-up in 18 days.

Performance of This New Accelerometer Is Spectacular!

And CEC's Type 4-202 Strain Gage Accelerometer is also the smallest on the market...measuring just one cubic inch.

Here are some of the performance characteristics that make the 4-202 infinitely superior to any other linear unbonded strain gage bi-directional accelerometer:

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Deep Drawing

ACF Makes Big Steel Cups In Polaris Work

Solid rocket motor cases over s feet long with a single circumferenti welded seam are possible through unique metal working capability ACF Industries, Inc.

The firm has successfully cold-dee drawn high-strength steel sheets in cups 38 in. deep and 54 in. in diamete in a second-stage *Polaris* missile a vance test program.

Four forming passes in ACF 4,000-ton press are necessary to cor pletely shape the cup. After each de drawing step, the workpiece is proce annealed and specially prepared in seven-tank phos-lube line.

The phos-lube process, largest the free world, treats the metal wi a phosphate coating which acts as host for the lubricant. This prever metal-to-metal contact between t workpiece and the forming dies.

The press itself has a 120-in. strok 168 in. of daylight and a colun clearance of 92 by 160 in.

The process begins with the she circles, 108 in. diameter and 0.080 i thick, moving through a simple, straig draw. This results in a shallow cup in. deep and 85 in. in diameter.

After phos-lube treatment, an init reduction draw deepens the cup by in. and reduces the diameter to 76 A second reduction draw extends t depth to 20 in. with a diameter of in. The final reduction draw produc a cup exceeding 38 in. in depth wi a diameter of approximately 54 in.

According to Donald B. Howa ACF Staff Metallurgist, the most cr ical part of the operation is keepi the thickness and hardness unifor Electronic micrometer checks show th the thickness tolerance of 0.010 in. achieved.

In some cases, ACF has reve deep drawn the final cup.

Two steels were involved in the pr gram. U.S. Steel's X200 and MX-2, high-strength alloy steel developed the Mellon Institute of Philadelphia f the Navy.

Technique Simulates Case Cracks Non-destructively

Cracks which closely resemble th occurring in rocket cases are being si ulated at the Stanford Research In tute, for Aerojet-General Corp.

The project called for a nondestru tive means of determining how big crack in a case could be tolerated fore it caused a missile failure.

In the past missile cases were test by pressure tests. The trouble was t

← Circle No. 13 on Subscriber Service C

the tests themselves increased the cracks. When launch time came, the missile might fail because of a relatively harmless crack enlarged by repeated testing.

Metallurgist Alfred Neiman and physicist Ernest Chilton of SRI went to work on the problem. They found out that they could not etch a crack, since this would cause non-normal conditions in the metal around the area. And they had to be able to reproduce cracks of certain dimensions.

The SRI team's answer was to spark-machine a thin slot into the metal, then lip it into liquid nitrogen. When the teel drops to the liquid nitrogen temp-rature the piece is put into a holder. \ steel stud with a blank cartridge is ired against the sheet on the side op-posite the slit, producing the crack. By machining the same size slit, and firing he same charge bullet, the crack size an be reproduced.

By analytical methods the team is etermining what loads or stresses cause ertain size cracks, and what loads en-arge the crack so that it causes a mis-ile case failure.

Amphenol-Borg Begins Big Plant Expansion Program

Amphenol-Borg Electronics Corp. ill sink $4.5 million into plant expan-ons during the next year.

Construction will begin immediately n a 125,000-sq.-ft. addition to the mphenol Connector Division plant in roadview, Ill. The $1 million building ill house the Punch Press department ow located in Cicero, Ill., and assem-y operations at another location in hicago.

By May, 1961, a new 60,000-sq.-ft. uilding for the Amphenol Distributor ivision will be completed. Cost is esti-ated at $560,000.

Borg Fabric Division plant in Jef-rson, Wis., will get a 47,000-sq.-ft. dition.

Amphenol-Western Division has rchased a 2½-acre plot adjoining its esent Chatsworth, Calif., site. A 45,-0-sq.-ft. plant addition will bring pense there to $475,000.

Amphenol's wholly owned subsid-ry in Great Britain will move its elec-nics components operations to a new 00,000 facility being built at Whit-ble in Kent, 54 miles from London. nstruction of a $1.3-million second ctory for fabric manufacture is also der way at Whitstable.

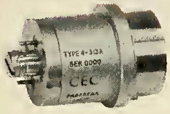
The company also has plans to quire facilities in the New York City a to house the newly created Am-enol-Eastern Connector Division.

The program will be financed from nings, current available cash and bt financing.

C le No. 14 on Subscriber Service Card.→

CEC makes them precise...

Type 4-312A Pressure Transducer



Type 4-313A Pressure Transducer

4-001 Closed line Adapter

Versatility makes them popular

4-008 Chamber-type Adapter

For adaptability in pressure measurement, there's no equal to the pair of unbonded strain-gage instruments pictured here actual size. With adapters they can be flush-mounted ... chamber-mounted ... water-cooled ... water-proofed.

A workhorse with a thousand uses, Type 4-313A is available in absolute and gage models that measure pressures from 100 to 5000 psi in a temperature range of –100°F. to +300°F.—with superior performance in shock and vibration environments. The unit mates with a 4-008 chamber-type adapter as well as with an adapter for use in closed-line pressure measurements.

Type 4-312A, available in absolute, gage and differential models, is a general purpose transducer particularly suited to aerodynamic pressure studies. It operates in a range of 10 to 150 psi in gage, absolute and unidirectional models and from ±5 to ±50 psi in differential models. Used with a 4-001 adapter, it is ideal for closed-line applications.

Call or write for complete information. Ask for Bulletin CEC 1541-X1, Type 4-313A; Bulletin CEC 1540-X1, Type 4-312A; Bulletin CEC 1558-X1, Adapters.

Transducer Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

A SUBSIDIARY OF **Bell & Howell** • *FINER PRODUCTS THROUGH IMAGINATION*

hardware job now . . .

Era of Space Communications Begins

Courier can handle 3.5 million words per day; paves way for more sophisticated 24-hour Advent system

The successful orbiting of *Courier I*—the world's first active communications satellite—appears to have erased all doubts as to the technical feasibility of establishing a space communications system.

As one electronics expert put it: "It's a hardware job from here on."

A two-stage *Thor-AbleStar* launched the 500-pound *Courier I* satellite into orbit from Cape Canaveral at 1:50 P.M. EDT Oct. 4—third anniversary of the launching of *Sputnik I*. The 106.9-minute orbit had a perigee of 602 miles, an apogee of 752 miles.

On its first orbit the delayed repeater satellite transmitted a message from President Eisenhower in Washington to U.N. President Frederick Boland in New York. The message was transmitted from Fort Monmouth, N.J., to the satellite and relayed to Puerto Rico. Then it was transmitted back to Washington and sent to the U.N. by regular communications channels.

Courier I's success opened the way for establishing both military and commercial global satellite TV and radio networks. It also paved the way for Project *Advent*—the Army's advanced system of one-ton, 24-hour communications satellites.

Courier is capable of handling almost 3.5 million words per day—the equivalent of the wordage contained in 465 standard-size newspaper pages. This capacity is based on a 5-kilobit-per-second information rate (average word is equal to 44.4 bits).

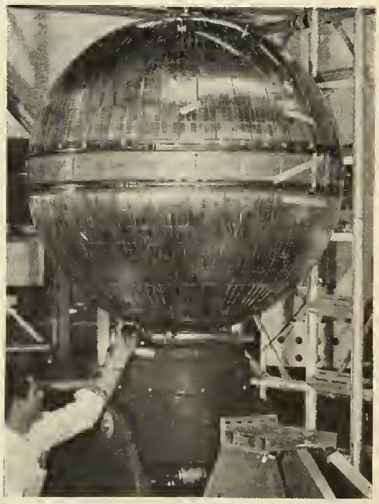
• **Complex package**—*Courier* is the most complex and sophisticated communications system ever put in a small package. It can function either as a delayed-repeater station or as a real-time relay. It will provide 20 continuously available 100-wpm teletype channels or, alternately, low-priority voice channels.

The satellite contains four separate systems: VHF link, microwave link; telemetry system, and radio beacon. Most of the circuitry and equipment is duplicated to achieve a high degree of reliability.

• **Operates only on command**—*Courier* provides a relatively secure method of communications. It must receive a properly coded signal before accepting or transmitting traffic. Also, due to position requirements, reception, interception and jamming pose difficult problems for an "enemy" station.

In orbit, the satellite transmits a low-powered acquisition signal. On acquiring this signal, the ground station transmits a coded command to switch the satellite from standby to active operation. The acquisition transmitter is switched off and the VHF telemetry transmitter begins sending data to the ground station. The satellite acknowledges receipt of the first command and begins microwave transmission, which provides a beam for automatic tracking by the ground antennas. Subsequent commands to the space station are made via the microwave link.

Each command is preceded by a coded signal which is changed according to a predetermined pattern. In case the signal is lost, the satellite auto matically returns to the standby mod and the operational sequence may b repeated.



COURIER package is most sophisticated of small size ever produced. Circuitry and equipment are mostly duplicated.

Data relay is accomplished durin the 10-15 minute period in which th satellite is within range of the groun station. At the end of this period, it i commanded to return to standby.

As the satellite passes over the nex station, virtually the same procedure i followed to acquire and commanc Upon receipt of the proper code, dat received earlier is played back an transmitted to the ground. The groun station may transmit traffic for furthe relay at the same time it is receivin messages.

• **VHF link**—The VHF link (10C 150 mc) is used for initial acquisitio and telemetering. Equipment in th satellite includes two 50-mw acquisi tion transmitters, two 1.5-watt teleme try transmitters, two command re ceivers, diplexer, and antenna.

The ground station is equipped wit one 100-watt transmitter, two receivers and a tracking antenna. The antenn has an 18° beamwidth and 18 db gair The two receivers operate together t provide quick polarization.

• **Microwave link**—Messages an operational commands are carried b the microwave link (1.7-2.3 km). Th satellite contains four 5-watt transmit ters, four receivers, one receiver base band combiner, and two antennas fo handling traffic at these frequencies.

In the active mode, two of th transmitters—tuned to slightly differen frequencies and connected to separat antennas—operate at one time. All fou receivers operate at the same time The baseband combiner accepts th output signal from the receiver wit the most favorable signal-to-noise ratic

On the ground, the microwav equipment includes one transmitte four receivers, one receiver baseban combiner, and an antenna. The an tenna is the same 28-footer used fo the VHF link. Beamwidth is 1.3 de rees and gain 42 db. Ground receivers erate together to provide polariza- on and frequency diversity. Outputs e combined to provide a single base- nd output.

- **Telemetering system**—The tele- etering system performs two func- ns: monitoring internal conditions in e satellite, and acknowledging com- ands received.
- **Ground stations**—The *Courier* stem at present uses two ground sta- ns; near Ponce, Puerto Rico, and Ft. onmouth, N.J.—both Army Signal orps installations. Other stations will e added as the project progresses to rovide a truly global system.

Courier's Vital Statistics

Payload weight	500 lb. (approx.)
Payload size	51 in. diameter
Satellite spin rate	40 rpm (approx.)
Orbit	602-752 mi. (approx.)
Satellite speed	14,400 mph (approx.)
Power supply	NiCd batteries (28v., 12 amp-hr.)
Charging supply	19,152 solar cells
Power consumption	Standby: 10 w Active: 225 w
Launch vehicle	AF Thor-AbleStar
Contractors	Payload: Philco Corp. Antennas: Radiation, Inc. Ground equipment: ITT

Next Scout Shot Will Attempt Orbit

Propulsion, separation, guidance and ntrol proved out successfully on the ur stages of the all-solid *Scout* satel- te launcher last week. The next shot, about two months, will be orbital.

Telemetry on engine performance d an Air Force radiation experiment as received from the 112-lb. payload r 63 minutes of the 80-minute flight om Wallops Island, Va., to an altitude more than 3500 statute miles and out 5800 miles down the Atlantic issile Range.

Officials of the National Aero- utics and Space Administration said e launch Oct. 4 was the first known ght of a guided all-solid propellant hicle with orbital capability. So far is known, the Russians have never ne anything comparable, said Elliot itchell, assistant director for propul- on in NASA's Office of Launch Ve- cle Programs.

By programing the vehicle a little fferently, it would have been possible put the payload into orbit. However, incent L. Johnson, acting chief of out class vehicles, reported the tech- cal staffs felt there was more as- rance that the needed data would be tained if the orbit attempt were de- rred until *Scout*-3.

Three stages of *Scout*-1 fired when was launched July 1. However, the ird stage developed excessive roll and sudden shift of the radar indicated at the vehicle was deviating from its ogramed course. As a result, igni- n of the fourth stage was prevented command from Wallops Island as a fety precaution. Subsequent examina- n of telemetry showed that the ve- cle was still on course.

To prevent repetition of the ex- ssive roll, the thrust of the roll- ntrol jets was more than doubled in *Scout*-2. Johnson reported the new jets appeared adequate in the first scan of the telemetry.

Scout Data

Height	72 ft.
Weight on pad	36,600 lbs.
Payload	112 lbs.
Altitude reached	3500 mi.
Distance traveled	5800 mi.
Stages	1. Aerojet Algol, 115,000 lbs. thrust; 2. Thiokol Castor, 55,000 lbs. thrust; 3. Hercules Antares, 13,600 lbs. thrust; 4. Hercules Altair, 3100 lbs. thrust
Guidance	Minneapolis-Honeywell
Payload capability	150 lbs. in orbit

The *Scout* program will be transferred to Wernher von Braun's George C. Marshall Space Flight Center at Huntsville, Ala., in about a year, Johnson reported. Langley Research Center has handled the job during initial development, with the aid of five major contractors.

The *Scout* development program calls for firing four vehicles in the current fiscal year and four in FY '62. Some time before the vehicle becomes operational, launching and assembly will be turned over to a prime contractor — probably Chance Vought, which has provided launch tower, frame and motor transition sections.

Mitchell said NASA is cooperating closely with the Air Force *Blue Scout* program, a more varied and in some cases more sophisticated program. The first *Blue Scout*—a smaller four-stage vehicle without guidance or orbital capability—was launched from Cape Canaveral last month. NASA has ordered vehicles for the first nine *Blue Scouts*. Arrangements beyond that are uncertain.

Mitchell and Johnson declared the development of *Scout* will greatly reduce the cost and complexity of launching small satellites. It will have an orbital capability between *Juno II* and *Thor-Able*—between 100 and 200 lbs. However, the overall cost—vehicle plus launching costs—of a *Thor-Able* is three to four times the projected cost of a *Scout*.

In the immediate future, *Scout* will be launched from existing towers at Wallops Island and Cape Canaveral. Under consideration is a proposal to build a tower in the NASA area at Pt. Arguello, Calif., for launchings down the Pacific Missile Range.

Another great advantage of *Scout*, Mitchell declared, is the relatively low cost of launch facilities.

The 72-ft., 36,600-lb. launch vehicle lifted a payload of 112 lbs. of instruments—including the 78-lb. Air Force package—and 80 lbs. of performance-measuring instruments on the first and third stages.

The Air Force package, prepared by the Special Weapons Center of Air Research and Development Command, was designed to measure the intensities in both Van Allen radiation belts. Such a device is also capable of detecting nuclear explosions in the space near the earth, through the artificial Van Allen belts such explosions establish, as demonstrated by Project *Argus*.

Besides Chance Vought, the major contractors are: Aerojet-General, first stage; Thiokol, second stage; Hercules Powder Co., third and fourth stages; Minneapolis-Honeywell, guidance and controls.

Saturn Booster Redesign Could Make Up Lost Time

by Jay Holmes

HUNTSVILLE, ALA.—Project *Saturn*, America's best hope for boost power to better the Soviets soon in space, has entered a critical engineering phase.

Early success or a delay of several months hang in the balance as Wernher von Braun's rocket engineers redesign the prototype SAT booster thoroughly in preparation for a series of static tests beginning in mid-November.

Oswald H. Lange, boss of the *Saturn* program at the Marshall Space Flight Center of the National Aeronautics and Space Administration, says he hopes the November series will provide all the data needed to finish construction of the first flight *Saturn*.

The flight bird, partially assembled, lies in a cradle in a Fabrication Division building here. Four of the eight engines —the four that will not swivel—are attached to the structure. Assembly will be completed after the November static tests. Meanwhile, single Rocketdyne engines are being tested while being swiveled.

Modifications of the prototype SAT are being made on the test stand, where it was erected last spring in preparation for the first series of static tests. In addition, some changes are being made on the stand itself.

• **Series delayed**—Last June 15, at the dedication of an IBM 7090 computer here, Von Braun announced that a second series of tests would begin in six to eight weeks. A month later, at the NASA-Industry conference in Washington, Lange stayed with this schedule, saying tests were to begin in August.

But as the promised time approached, it became apparent from study of telemetry tapes from the first series that many more changes would be necessary.

"We could run a series of tests now if we wanted," a Marshall Center spokesman said. "But it wouldn't be worth the expense and time, since we now know other changes must be made."

The second series was first rescheduled for the end of September. Then more data turned up, more changes became indicated, and the start was pushed back to mid-November.

• **Mid-'61 still target**—Is this slippage? "There is no question that static testing is three months behind schedule," says a NASA headquarters spokesman. "However, the technical people believe that most or all of the time will be made up by the November tests."

From top to bottom, everyone maintains that the first test is to come in mid-1961, as previously scheduled. During a tour of the Fabrication Division, one official told M/R the flight would be next summer. A reporter for another trade magazine was told the test would be June or July, 1961. Lange was perhaps a little more cautious, however, in his statement at the Marshall Center's Sept. 27 industry briefing, saying merely, "The initial firing will come in 1961."

While the first *Saturn* hangs in the balance, the NASA center is going to industry for major components in later birds of the R&D program. Bids are being asked on 42 propellant tanks, 70 in. in diameter, for *Saturns* No. through No. 10, which are to be flow in 1963 and 1964. Two spare tanks ar included.

Huntsville is receiving bids Oct. 3 on a contract to tool up by Oct. 15 1961, deliver the first tank by April 8 1962, and the 42nd tank by May 6 1963. Tanks for the first five *Saturn* are being built in-house. Under presen scheduling, *Saturn* No. 6 will be th second of five flown in 1963. It will b the third of a series tested with liv first and second stages and dumm third stage.

Major *Saturn* contracts to be let:

–A new second stage, designate S-11, which will be in the later, four stage *Saturn C-2*, clustering four Rocketdyne J-2 liquid hydrogen-LOX engines of 200,000 lbs. thrust apiece—bidders' conference next spring, proposals to be evaluated later in the year

–Production of the operational S- booster, beginning with *Saturn* No. 11 to be flown in 1964 or 1965—procurement to begin in Fiscal Year 1962.

Bell's Maser to Broaden Spectrum

NEW YORK—Bell Telephone Laboratories today demonstrated an operating optical maser aimed at future communications systems. Similar in many respects to the system announced some weeks ago by Hughes Aircraft, the optical maser opens up possibilities of a vastly extended communication spectrum far beyond that of conventional radio frequencies.

Preliminary experiments have been conducted by Bell scientists between laboratories located at Murray Hill, N.J., and Holmdel, N.J.—a distance of about 25 miles.

The optical maser produces an intense and extremely narrow beam of light. Within its narrow cone and frequency band, the beam is more than a million times brighter than the sun. With further developments, such a beam might be used for interplanetary and earth-space communications purposes as well as in a variety of scientific applications.

Bell scientists pointed out that the optical maser fills all four requirements for use in a communication system for electromagnetic transmission of information: energy transfer, directionality, modulation, and frequency selectivity.

• **Heart of ruby**—The heart of the BTL maser is a synthetic ruby rod, 1½ in. long and ⅕ in. in diameter. The two ends of the rod are polished until extremely flat and parallel, then covered with a reflecting layer of silver thin enough to be slightly transparent. This ruby rod is held in the center of spiral neon photoflash lamp, and illuminated with an intense flash of ordinary white light. The synthetic rub is infused with "impurities" of chromium to enhance its emission efficiency

Under the stimulated emission, th ruby produces light sixty times mor monochromatic (of a single frequency than the ordinary fluorescent light fro ruby.

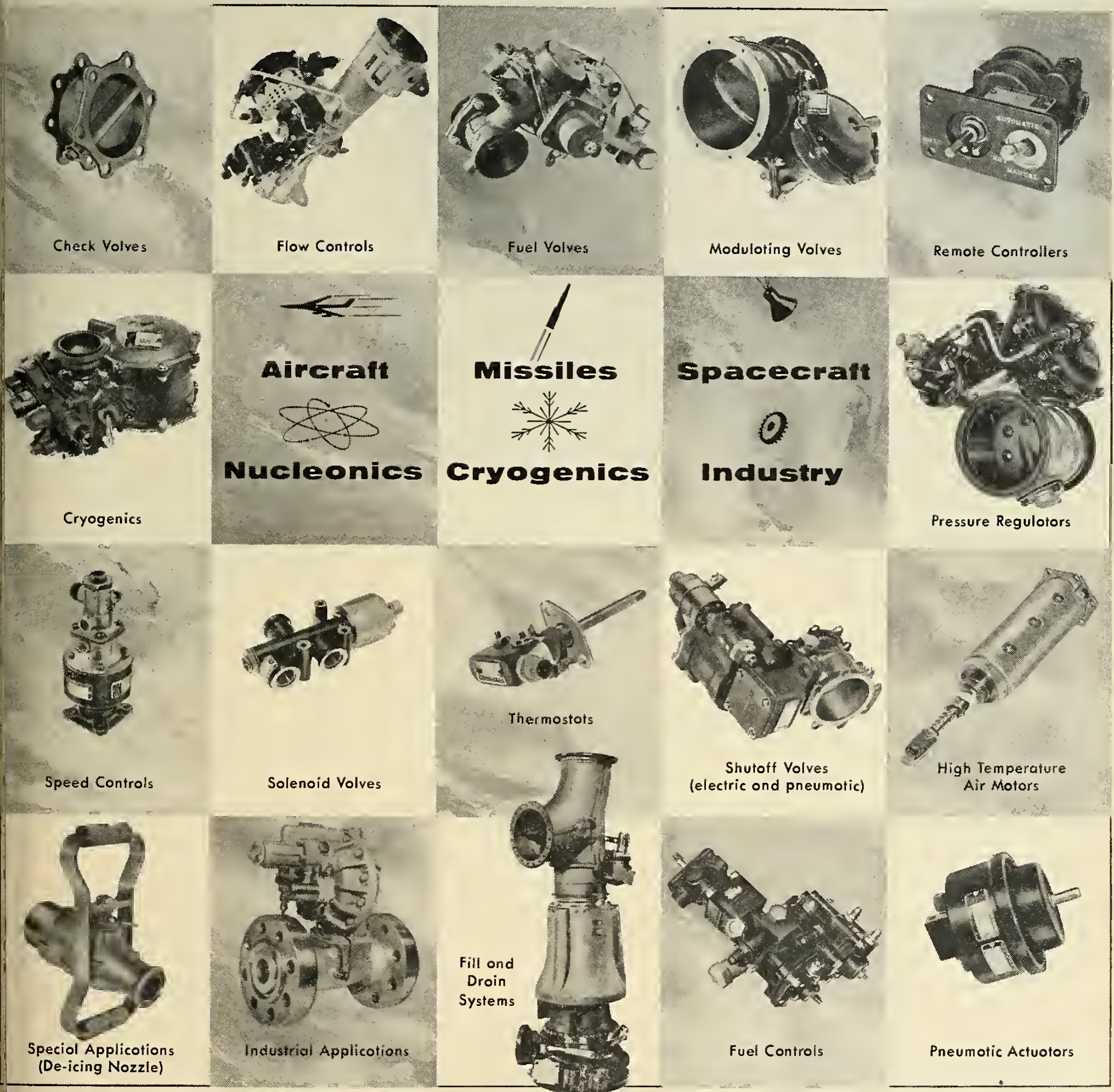
Secondly, the light is "coherent," o of a single phase. This is the primar difference between ordinary ligh sources (which diffuse widely over distance) and the maser light emission Such coherence is a primary requisit for application in long-distance communications.

Thirdly, the cone angle of the rub light is only one-tenth of a degree Within this cone, the intensity of th light is far higher than could be obtained by the ordinary fluorescen process.

In the recent experiments, re flashes from the ruby maser transmitte at Holmdel were clearly visible to th naked eye at Murray Hill, and illuminated a circle there of only 200 feet i diameter.

Other applications of the optica maser mentioned by Bell scientists wit their eye on the future include the control of chemical reaction, and the possibility of using the pressure of suc directed light to control the orbits o satellites.

Valves and controls



AiResearch *has produced more than one million high performance valves and controls for gases and liquids operating at temperatures from −420°F. to +2000°F. and pressures to 6000 psig.*

Reliability and compatibility of systems applications are insured when *all* components are of AiResearch design and manufacture—backed by more than 20 years of experience in valves and controls and the most complete testing and production facilities available.

Please direct your inquiries to Control Systems,
AiResearch Phoenix Division.

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ystems and Components for: AIRCRAFT, MISSILE, SPACECRAFT, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

Circle No. 4 on Subscriber Service Card.

Automatic Electronic Systems Checker

A versatile, low-cost automatic checker for electronic systems has been developed by General Electric's Light Military Electronics Department.

GEPAC (General Electric Programmable Automatic Comparator), is intended to rapidly check the operational readiness of aircraft, missile and space electronic systems. The device can be used for factory test and quality control as well as on the Flight line.

By utilizing punched-tape test programs and appropriate adapters, GEPAC automatically checks eight basic electrical parameters of the equipment under test. Measured values are compared to allowable high and low limit values which have been programed on the tape. Test results are visually displayed in HI-LO-GO form or can be printed out.

If a test result is acceptable, GEPAC proceeds to the next test. Should a failure or malfunction be detected, a NO-GO indication is presented and testing is stopped. The operator may then turn to a subroutine on the tape and GEPAC will automatically proceed to isolate the module which is at fault.

Circle No. 225 on Subscriber Service Card.

Pure Cadmium Telluride

Semi-Elements, Inc. is manufacturing a semiconductor-grade cadmium telluride polycrystalline material that can be used as a basic material for growing single-crystal cadmium telluride. It is available in high-purity form and in doped concentrations P-type and N-type, with carrier concentrations ranging from 10^{16} to 10^{19} per cubic centimeter.

Circle No. 226 on Subscriber Service Card.

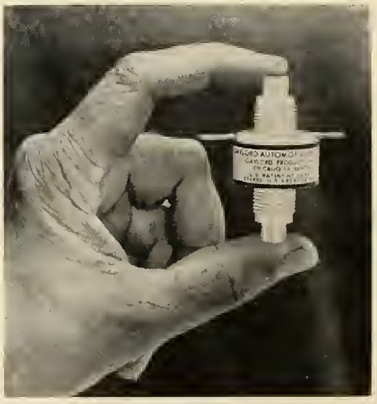
Motion Detector

A simple, reliable and extremely low cost device for detecting motion or the lack of motion has been developed by the Research Laboratories of Gaylord Products, Inc.

Although designed to "sense" increments of rotary motion as little as or less than ½ RPM, the device can also be utilized to detect linear motion by a simple conversion to rota motion.

In addition, the motion detect can be manufactured for a great rang of low-speed sensing requirement when the detection of slow-downs speed-ups is required.

Circle No. 227 on Subscriber Service Card.



Multipurpose Test Chambe

High Vacuum Equipment Cor subsidiary of Robinson Technical Pro ucts, Inc., has introduced a produ line of multipurpose self-contained e vironmental test chambers. With th addition of optional equipment, th chambers can be adapted to "dry box welding. Cooling and heating equi ment accessories are available to furth expand the scope of the units. Th chambers are designed and engineere to specification and can be adapted t fit a multitude of jobs, one of which Electron Beam Welding. The chambe sizes lend themselves to the installatio of the H.V.E. Corp. orbiting electro beam gun for doing closed loop weldin or butt welding long tube sectio which, because of configuration, cann readily be moved but are held statio ary while the electron beam gun rotated.

Circle No. 228 on Subscriber Service Card.

Shock Proof Recorder

A miniature missile-borne magnet tape recorder, designed to recor through a 500-g impact deceleratio and survive a 1500-g shock witho loss of recorded data, is being develope by the Westrex Corp., a division Litton Industries.

Fourteen tracks on one-inch tap are utilized to record data from a celerometers and other types of tran ducers. Recording can be accomplishe with an inline Westrex 14-track ma netic head or a staggered array of tw 7-track heads, depending on cross-tal requirements.

Circle No. 229 on Subscriber Service Card.

High Dielectric Film

A film-forming and moldable d electric (Cyanocel) having the highe dielectric constant (12.5) of all know organic film-forming materials has bee developed by American Cyanamid C

Clear, transparent films as thin 0.1 mil or as thick as 5 mils or mo have been cast from solutions of C anamid's highly cyanoethylated cell lose in a number of organic solvents solvent mixtures. At a frequency of 6 cycles, the 2-mil films have a dielectr nstant of 10-15 and a dissipation fac- r of 0.010-0.025.

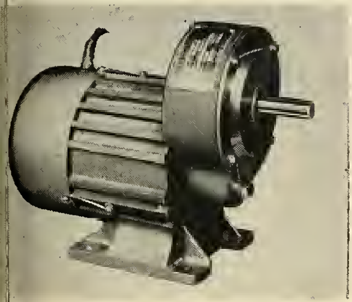
In addition to their unusual electric operties, films of Cyanocel have good xibility and physical strength. At °C and 50% relative humidity, 2-mil ms have a tensile strength of 5380 i and a Young's modulus of 0.34 x ^{6} psi.

Circle No. 230 on Subscriber Service Card.

duction Motor for GSE

Kearfott Division of General Pre- ion, Inc. is marketing a DEF-15-1 duction Motor to its extensive line miniature and subminiature special rvice motors for both military and dustrial uses.

Thermally protected and explosion oof, this continuous duty motor is tally enclosed, fan cooled, base unted, and ruggedly constructed. e DEF-15-1 unit qualifies according the humidity, salt spray, sand, dust, ock, and vibration specifications of L-E-5272A, and it also conforms the applicable portions of MIL-M-769A.



ircle No. 231 on Subscriber Service Card.

F st Response Valve

Designed for use with hydraulic fl ds, inert gases, hydrogen peroxide, V on "A," Buna "N," or nylon seats—d ending on the line fluid—provide f t response and positive sealing in a c ck valve manufactured by Marotta V lve Corp. The standard CVM4C n del has an operating pressure of 3 0 psig, with a high-pressure version t 4500 psig. All models operate at te peratures from −65°F to +160°F. M le ports per AND 10056-4 are for c nection with ¼ in. tubing or hose. O erall length is 2.280 in., diameter o 0.812 in. and weight 1.2 oz.

ircle No. 232 on Subscriber Service Card.

echanical Vacuum Gage

Consolidated Vacuum Corp. has a c pletely mechanical diaphragm gage fc use in measuring total pressures o all gases from atmosphere to 0.2 m Hg.

The inexpensive gauge, known as th GHD-100, was designed for installation directly to a vacuum system and requires no electrical connections. Its principle of operation is the deflection of a thin metal diaphragm by a change in pressure. The diaphragm is made of corrugated copper-beryllium.

Circle No. 233 on Subscriber Service Card.

Numerical Control System

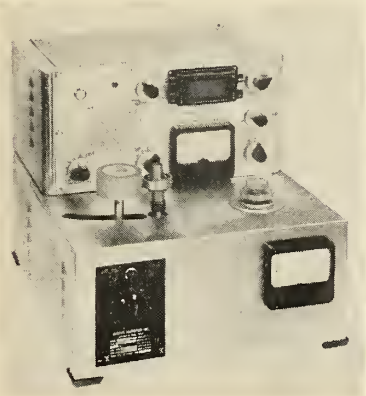
The Singer numerical control system, offering a simple, straight-forward approach to numerical control, is available from Diehl Manufacturing Co., a subsidiary of The Singer Manufacturing Co.

The Singer system provides up to ±0.0002 on a 40 in. work table, and flexibility and economy of operation through modular design. Modular components include a tape reader, distributor, digital analog converter, notch phase discriminator, amplifier, DC power supply, motor gear drive, position indicator control and servo-micrometer. Rapid change of these units is easily accomplished by a plant technician.

Circle No. 234 on Subscriber Service Card.

Ball Bearing Analyzer

An all electronic instrument designated BA-20-2 and designed specifically for the non-destructive analysis of ball



detects angles to .1 second

even after 100-G shock test

universally accepted

MICROPTIC AUTO-COLLIMATOR

The master instrument to set up and check angles to .1 second over 10 minutes of arc. With simple accessories it establishes squareness, parallelism, flatness, angles, and circular spacing under normal shop conditions independent of distance and temperature. Used as standard for testing of surface plates and machine tool alignment, control of ultra-precision gear cutting devices, test fixtures and tables for missile guidance units.

New . .
The Microptic Auto-Collimator with photo-electric read-out, as original equipment and conversion unit.

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DIVISION OF ENGINEERING AND SCIENTIFIC INSTRUMENTATION
431 SOUTH DEARBORN STREET
CHICAGO 5, ILL.

Circle No. 10 on Subscriber Circle Card.

and roller bearing quality has been introduced by Bearing Inspection, Inc.

Model BA-20-2 bases its analysis upon the vibrations produced by a rotating bearing, and it indicates unserviceable bearings, both visually and audibly, by means of a meter, C.R.T. display and a loudspeaker. Normal operation allows a complete non-destructive check of bearing surface conditions and cleanliness in an average time of less than 30 seconds.

Circle No. 235 on Subscriber Service Card.

Hydrogen Water Content

The Scientific and Process Instruments Division of Beckman Instruments, Inc. is marketing a Beckman Electrolytic Hygrometer Cell which makes it possible to measure the moisture content in hydrogen streams.

The cell is capable of removing and electrolyzing most of the water from hydrogen gas streams, with an insignificant amount of recombination.

Circle No. 236 on Subscriber Service Card.

Alloying Furnace

A Type LAC-55M Series Conveyor Furnace has been introduced by C. I. Hayes, Inc., for low-cost, highly critical alloying of electronic components, metal bonding and soldering, and similar exacting applications calling for extremely close temperature control througb the 300°C to 1100°C range. Principal design feature is a 3-zone temperature control within the 36-in. heating chamber to obtain correct temperature curves for the particular work being processed.

Circle No. 237 on Subscriber Service Card.

new literature

SPAGE AGE PACKAGING—Cushioning materials and reusable shipping containers used in the protective packaging of fragile Space Age products are fully described in an illustrated brochure from Nash-Hammond Inc. Shipping containers are discussed in detail, including materials, types and applications. Container materials range from steel to fiberglass and a wide variety of cushioning materials and shock-absorbing systems are employed to provide absolute protection.

Circle No. 200 on Subscriber Service Card.

INFRARED SOURCE CALIBRATION—A technical data sheet describing the Model PE-537 Infrared Source Calibration System, which provides a versatile means for checking,
maintaining and adjusting infra
reference sources to a known IR ra
tion power level, has been publis
by the Electro-Optical Division of
Perkin-Elmer Corp. The second
calibration system permits a simulta
ous comparison of infrared sou
with a secondary standard refere
source whose radiation characteris
are accurately known.

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A BUTTON
IS A NEEDLE
AND THREAD

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names in the news

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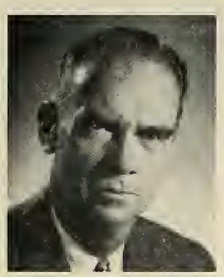
DIETRICH

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ROSEN

Herbert H. Rosen: Selected as cor- orate director of public relations for offman Electronics Corp., responsible or expanding activities in five divisions; onsumer Products, Industrial Products, ilitary Products, Science Center and emiconductor. Was formerly assistant di- ector for Educational Programs for the ational Aeronautics and Space Admin- tration.

John E. Clarke: Joins Computer Diode orp. as manager of applications engi- eering. Was formerly manager of appli- ations engineering at Silicon Transistor orp. and chief of applications engineer- g of the Semiconductor Div. of General nstrument Corp.

Robert C. Murrell: Appointed director, uality Control at Melpar, Inc. Formerly uality control manager-engineering divi- on, he now has responsibility for both e engineering and production divisions.

Jerome Berger: Former vice president nd general manager of the Brach Manu- acturing Div. of General Bronze Corp., amed sales manager of the Contract and pecial Products Div. of JFD Electronics orp.

Richard Lewis, Jr.: Appointed adver- sing manager for Spectrol Electronics orp., directing all advertising and sales romotion activities. He will report to . P. Vaughan, marketing manager. Prior joining the firm, was public relations nd sales promotion manager for Fair- hild Semiconductor Corp.

Capt. Frank W. Taylor (USN-ret.): oins Consolidated Systems Corp. as as- stant to the engineering vice president. or the past three years, he was head of e Auxiliary Ships Branch, Bureau of hips.

W. W. Smith: Named chief of engi- eering development at Babcock Electron- s Corp. He will head the firm's engineer- g development program in the field of mote guidance and control.

Robert V. Schmidt: Former vice presi- nt of United Research Inc., joins Nor- rop Corp.'s Norair Division as chief of search marketing.

Laurence R. Alexander: Appointed technical liaison manager of Patterson Moos Research Div., Leesons Corp. Has been a senior engineer on the firm's professional staff for the past seven years.

Robert L. Schwerin: Named quality control manager of ACF Industries Electronics Div. at Paramus, N.J. Was formerly manager of reliability and quality assurance in the government electronics division of Emerson Radio and Phonograph Corp.

Rear Adm. Neil K. Dietrich (USN-ret.): Elected a vice president of Hazeltine Corp. Prior to joining the firm he was director of Economic Research of the Charleston (S.C.) Development Board.

Frederick E. Carroll: Former project engineer promoted to the new post of Operations manager, Data Storage Operations, in the Computer Products Div. of Laboratory for Electronics, Inc.

Robert S. Meadows: Joins the electronics and avionics division of the Emerson Electric Manufacturing Co. as product manager of the firm's Electronic Systems Laboratory.

Ansel J. Gere, Deane A. Beytes, Andre M. Castellano: Named antenna engineer, project engineer and quality control manager, respectively, at Antenna Systems, Inc.

Dr. Egon A. DeZubay: Former manager of preliminary product evaluation in the research division of Curtiss-Wright Corp., joins Atlantic Research Corp. as a fuels and combustion specialist in the firm's nuclear engineering projects.

Roger W. Tuthill: Formerly assistant manager of the equipment engineering and development department for Air Reduction Sales Co., named manager-engineering in the firm's Special Products Dept.

Angus G. MacLean: Appointed senior applications analyst, specializing in the fields of high mathematics, statistics and space technology for the Computer Div. of Clary Corp.

Robert B. Abbey: Appointed senior product engineer at the Rialto rocket motor plant of B. F. Goodrich Aviation Products. Was formerly associated with Rocket Power/Talco.

Roy H. Olson: Former general manager of Motorola, Inc.'s Chicago Military Products Center joins Hughes Aircraft Co.'s communications division as director of engineering laboratories.

P. P. Hoppe and **C. D. Stephenson:** Appointed general engineering manager and product engineering manager, respectively of the Amphenol Connector Division of Amphenol-Borg Electronics Corp.

Bernhard Yagerman: Joins Telechrome Manufacturing Corp. as sales manager, Electronics Division. Was formerly with Underwood's Canoga Division.

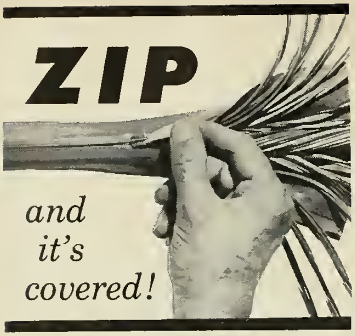
Dr. Norman Lee Barr: Elected head of biological sciences and systems department for General Motors Defense Systems Division. Dr. Barr's group will study natural and artificial environmental phenomena as related both to man's ground and space activities. He formerly served on the committee that established environmental control criteria for Project *Mercury*, selected the astronauts and developed their training program.

Karl R. Wendt: Elected executive vice president of Colorado Research Corp. He will continue as manager of the Research Dept. where he has been in charge of the company's digital television development program.

Michael Hacskaylo: A solid state physicist, formerly with the National Aeronautics and Space Administration, joins Semi-Elements, Inc., as director of research.

Harry A. Lucas, Jr.: Former sales manager of Minneapolis-Honeywell's Systems Div. joins CompuDyne Corp. as corporate sales consultant.

Joseph P. Gordon: Former general manager of Allen P. Dummont Laboratories' Electronic Tube Division, elected vice president of the Cathode Ray Tube Division of Electronic Tube Corp.



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M/R Readers Speak

(Continued from page 14)

strategic, tactical and defensive forces.

If we try too hard to do this, we may introduce an inflexibility of mind and maneuver which will react against us much as the Maginot Line did against the French. It is also sometimes difficult to know the meaning of the terms strategic and tactical. Our armed forces should have the utmost in flexibility, mobility and hitting power. If they have these things, they can be adapted to situations as they develop irrespective of what name you give them.

I would also caution against further centralization of the command of the armed forces. This country grew great because of individual initiative, by decentralization and by delegation of authority. Let us not defeat ourselves by monolithic organization of the armed forces which render progress and decision making even more difficult.

The main military needs in space are reconnaissance, communications, meteorological information and navigation. Fighting in outer space seems, at present, somewhat visionary. I can foresee that an enemy might want to deny our use of space for the above purposes. But I cannot subscribe to the view that future wars will be limited wars—limited to fighting in space. As long as men fight, they will fight on the land and on the sea with the best weapons they can get. We must not forget that territory must be held and that men must eat. For this we need ground forces and naval forces to control the seas.

There are some basic concepts appropriate to space which must be studied. If the air space above a nation's territory is under the jurisdiction of that nation, how high up does this jurisdiction extend? Should we seek to establish a principle of the Freedom of Space much the same as we have upheld our traditional doctrine of the Freedom of the Seas?

Your letter and proposals are stimulating and you are to be commended for bringing these vital issues to the fore.

Harry Sanders
Vice Admiral, USN (Ret.)
Dallas

Offer of Help

To the Editor:

AGREE WHOLEHEARTEDLY WITH LETTER TO NIXON AND KENNEDY. WHAT CAN I DO TO HELP?

LOU GALASSI
PROVIDENCE, R.I.

Wider Circulation Urged

To the Editor:

Congratulations on "An open letter to Richard Nixon and John Kennedy," also on your 9 point proposal. In my opinion, it would be a good idea if "An open letter . . ." and the replies could receive much wider circulation than they will get in M/R. It might help to wake the country up. Also while I am on the subject of wider circulation, it seems to i that it would be a good idea to have yc editorials by Mr. Clarke Newlon publish separately in book or booklet form. Th could be distributed much more wid this way. This could do much to count act the "Oh well, we're ahead of t Russians, we have color TV and th haven't" attitude in the country today.

David W. Johnst
Washington, D.C.

Wholehearted Agreement

To the Editor:

I hasten to express enthusiastic a wholehearted agreement with your op letter to Vice President Nixon and Se ator Kennedy and the nine-point p posal you have set forth. I also wish congratulate you on this public servi

R. H. Isaacs
Vice President-Military Relatic
The Bendix Corp.
Detroit

Reviews

MECHANICAL PROPERTIES OF SELECT ALLOYS AT ELEVATED TEMPERATURES, A. Pearl and others. Order PB 161761 fr Office of Technical Services, U.S. Dept. Commerce, Washington 25, D.C. 268 pp.,

Of six commercially available all designed for high temperature appli tions, Air Force-sponsored tests show A 286 steel to have the greatest stabil of properties over the maximum temp atures and time ranges of exposure us in this study.

Tests were designed to determ changes resulting from temperature al and changes resulting from structu alterations in the materials.

A PRACTICAL INTERPRETATION OF ELECTRIC MEASUREMENTS UP TO MC., J. J. Chapman and L. J. Frisce, Johns Hopkins University, for U.S. Ar Order PB 161545 from Office of Techni Services, U.S. Dept. of Commerce, Wa ington 25, D.C. 207 pp., $3.50.

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editorial . . .

Kennedy's Stand on Defense and Spac

THE OPEN LETTER which the editors of MISSILES AND ROCKETS addressed to the two Presidential candidates has served to break the barrier of silence both had maintained on the defense and space issue.

Senator John Kennedy was the first to reply and we are glad to carry his letter (pages 12 and 13) as sent to us under his byline on October 3. Vice President Nixon has indicated that his answer to M/R's open letter (carried last week) will be forthcoming shortly—probably in time for the October 17 issue.

In answering M/R's appeal that the defense and space issue be brought into the open, Senator Kennedy did well in making his stand clear. His detailed comments on each of the nine points in M/R's proposal were forthright and contained little equivocation.

The first point made by M/R was that the United States recognize that we are in a strategic space race with Russia. Senator Kennedy said:

"We are in a strategic space race with Russia and we have been losing : . . Control of space will be decided in the next decade. If the Soviets control space they can control earth, as in the past centuries the nation that controlled the seas dominated the continents."

He declined to be pinned down to dates for suggested space exploration accomplishments, but said: "All these things and more we should accomplish as swiftly as possible. This is the new age of exploration; space is our great New Frontier."

Commenting on "freedom of space" he did not specifically mention the role of the military, but said: "The United States must have a pre-eminence in security as an umbrella under which we can explore and develop space for the benefit of mankind."

He proposed a reorganization of the Department of Defense according to functions and missions. While he did not mention unified services or a single service, he proposed studying the feasibility of a Defense Department organization with five commands—Strategic, Tactical, Continental Defense, Material and Development.

Senator Kennedy proposed specific action in January of 1961 as suggested by M/R editors for modernity and mobility in the armed forces. He agreed on acceleration of *Polaris* and *Minuteman* programs, expanding conventional forces and construction of missile bases. He did not comment on the B-70 program. On budget ceilings he said:

"Defense spending must be based on the security needs of the nation not the pre-determined confines of a budget . . . Research cannot be started and stopped according to the whims of the budgeteer."

IN RESPONSE TO M/R's proposal to streamline defense regulations and procedures to make industry's defense and space role more effective, he said:

"Certainly defense regulations and procedures must be simplified, and the proliferation of secretaries, assistant secretaries, under-secretaries, special assistants and deputy assistants to secretaries, boards, commissions, councils and committees must be rolled back."

He said that national scientific goals "will be our first objective." On decision-making in the defense and space program, he wrote:

"The Democratic Party has strength in depth among dedicated men familiar with defense problems. They will have a mandate to speed the decision-making process, and authority to make affirmative decisions very quickly."

MISSILES AND ROCKETS takes pride in the fact that it has been in some degree instrumental in bringing the defense and space issue out into the open. We hope to carry Vice President Nixon's reply to our open letter in equal detail.

We have suggested that this issue be brought out further—specifically in the televised debates between the candidates. We feel that the facts are neither widely nor fully understood by the U.S. public. We feel it is vital to survival that they be understood.

Clarke Newlon

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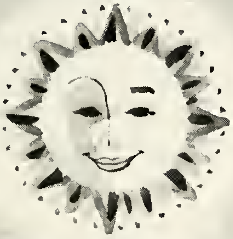

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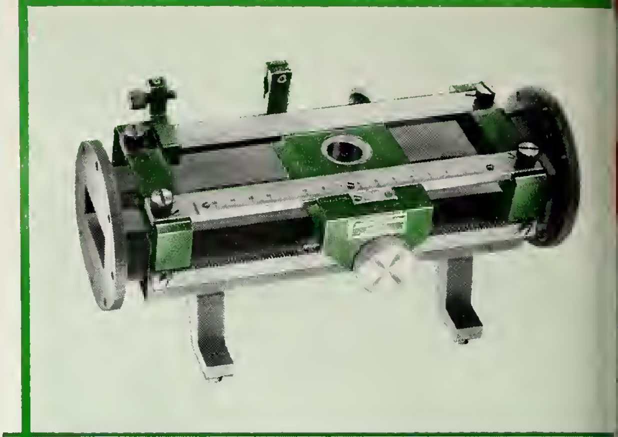

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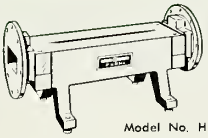

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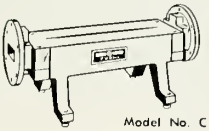

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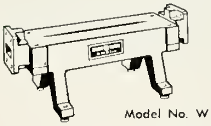

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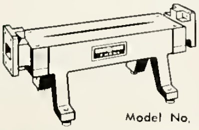

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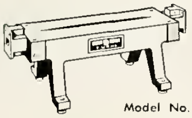

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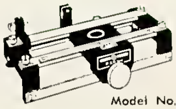

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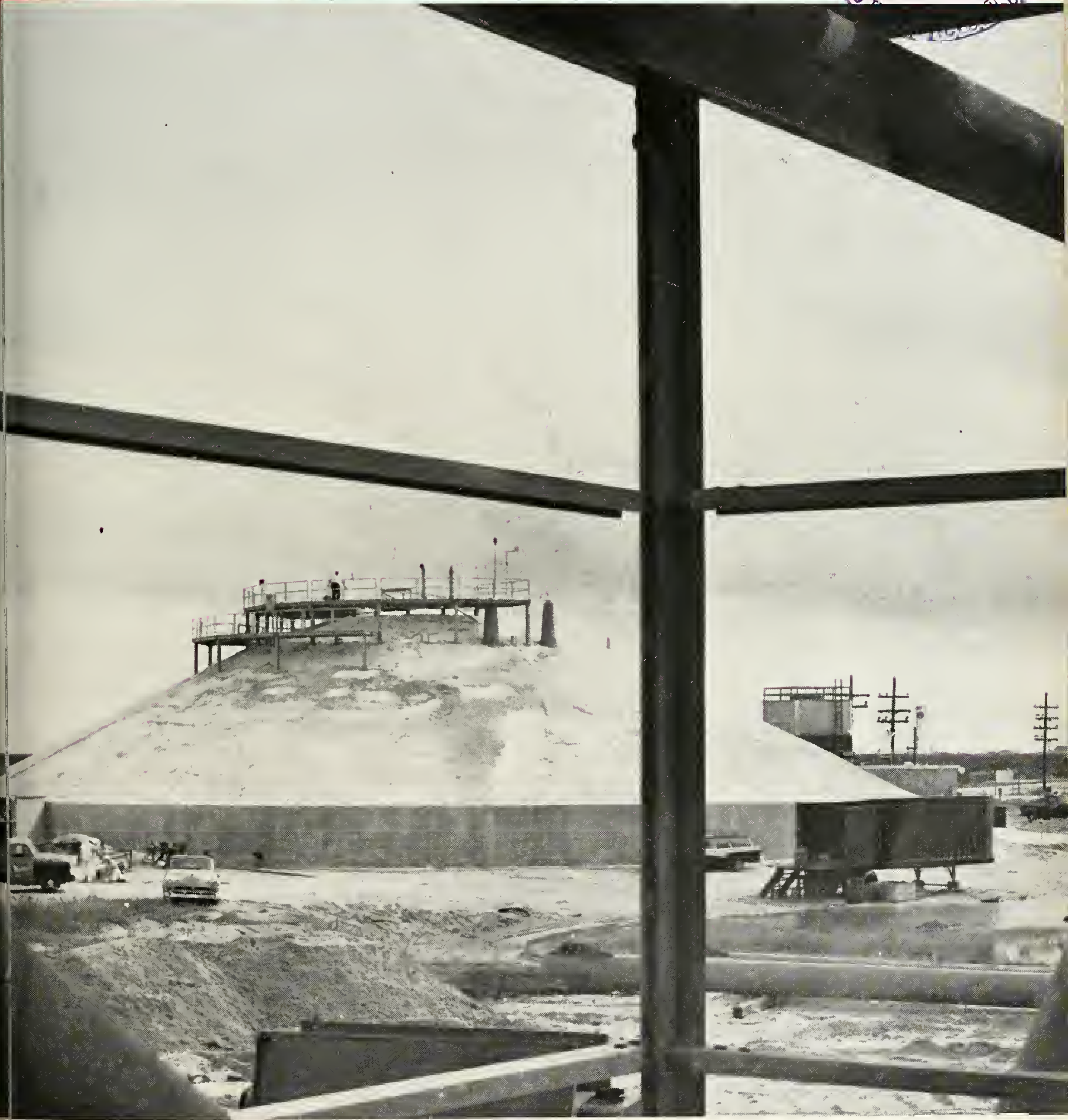

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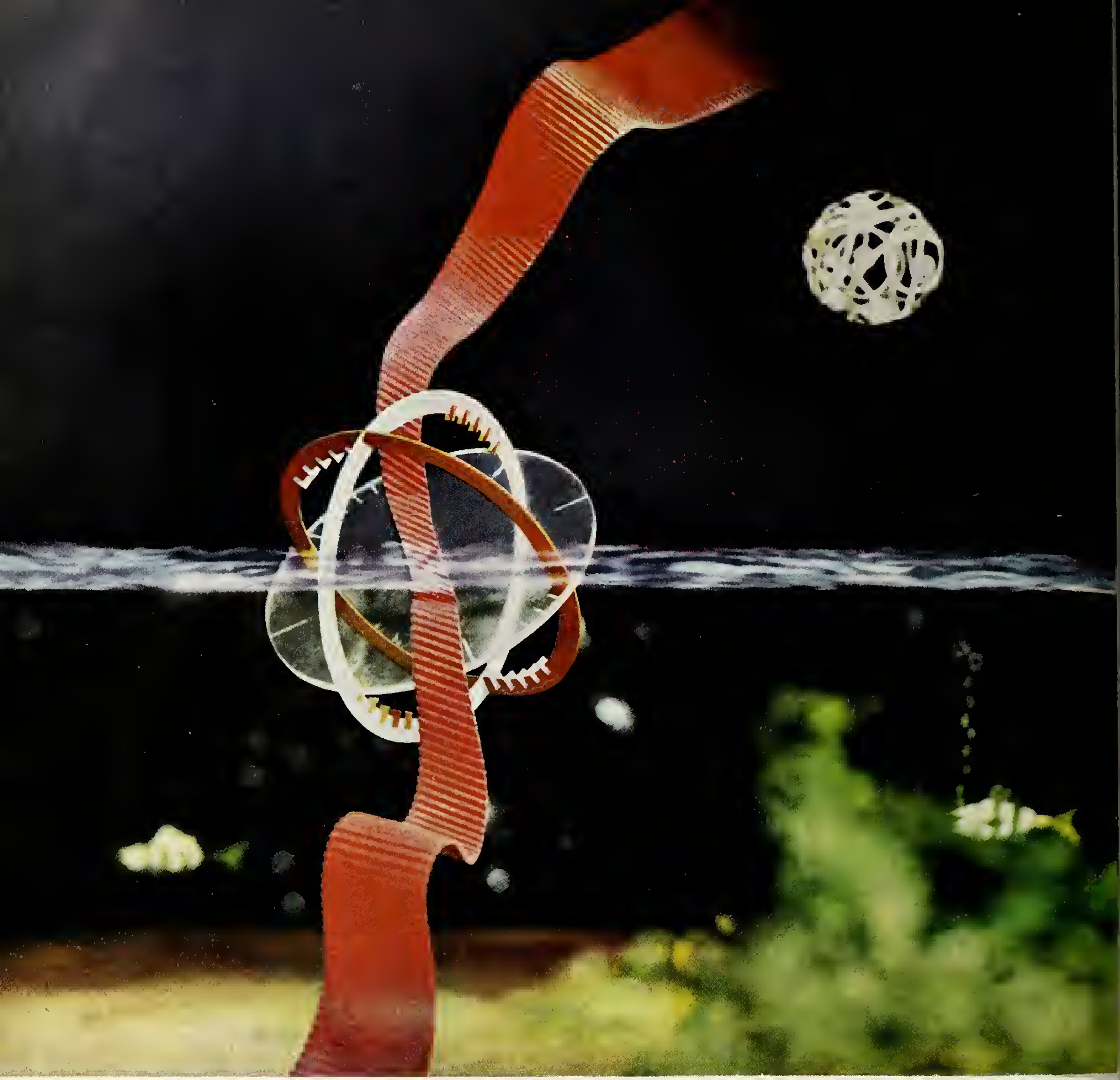

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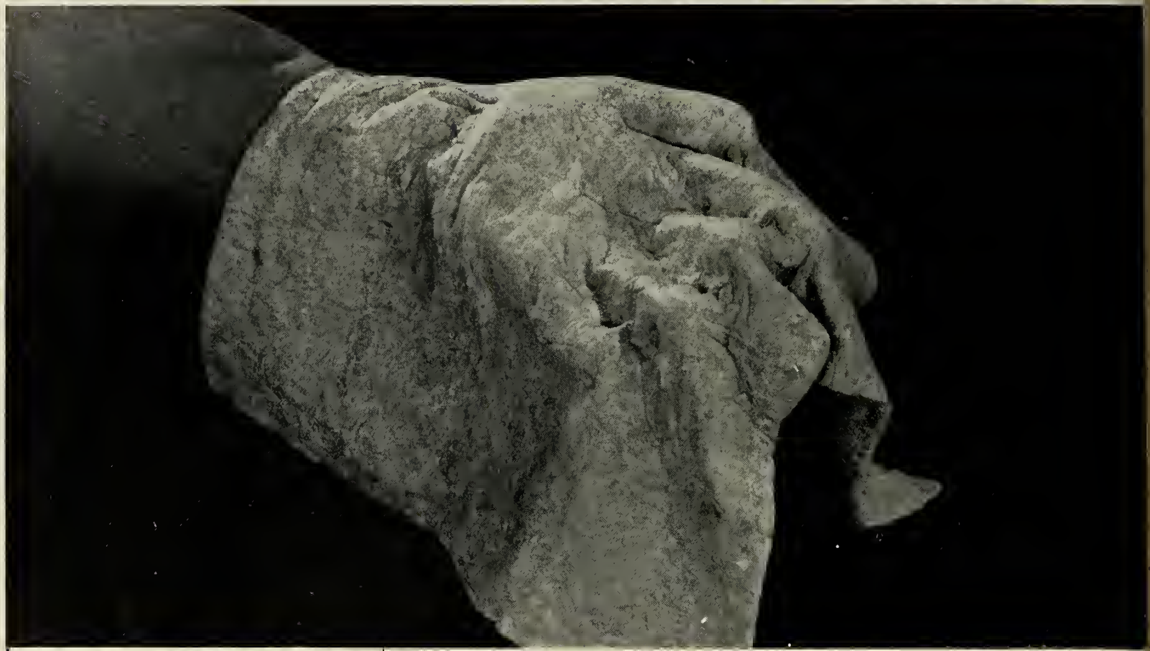

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October 17, 1960 Volume 7, No. 16

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THE COVER

Huge block house for Saturn test facility nears completion at Cape Canaveral. Contractor is Diversified Builders of Calif. Army photo by Lt. C. W. Stoughton.

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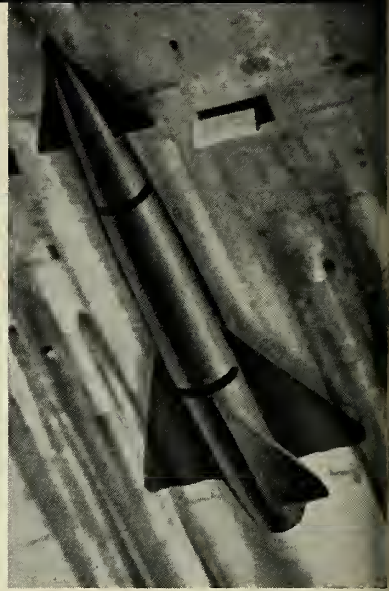
Britain's new deterrent system relies on two high-performance vehicles...



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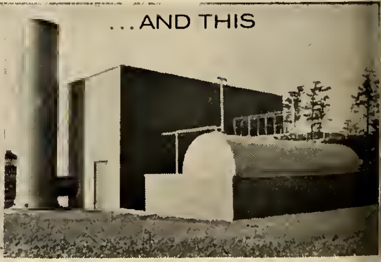

The Bristol Siddeley Industrial Proteus gas turbine engine powers a 3-megawatt turbo-generator.

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The Countdown

WASHINGTON

Candidates' Dilemma

Reluctance of the presidential candidates to commit themselves to hard defense spending figures for FY '62 can be attributed (at least partly) to this piece of news: Built-in increases in already going programs if allowed would force the next DOD budget being processed by the Budget Bureau to around $43.5 billion. This is almost a $2 billion jump in the current budget. So, if Kennedy or Nixon call for an increase, say of $2 billion, are they referring to the built-in increment or do they want it on top? The total would then hit $45.5 billion.

Speaking of Figures

Despite reports to the contrary, Countdown hears there still is no money being made available to R&D for a tactical ballistic missile *(TBM* or *TBX)* . . . The amount spent to date in the ANP (aircraft nuclear power) program now totals more than $1 billion with no flyable hardware in sight.

Mercury Investigation

Congressional plans for investigating NASA's slipping *Mercury* program are still indefinite as to a starting date. One and possibly more committees will begin an inquiry when Congress reconvenes in January. But, if an Ivan goes into orbit sooner, the investigations could well come shortly after the election. (What ever became of that shot Khrushchev was expecting last month, anyway?)

Probe May be Dropped

Another congressional investigation tentatively under consideration is a detailed review of slippage in the ICBM launching site construction program. Chances are that if slippage is stopped and some of the lost time is made up by January, the inquiry, which is still on the staff level, may be dropped.

Anti-Tank Decision Again

The Army's long-awaited decision on procurement of anti-tank missiles once more is considered imminent. But Countdown is told the decision may cover only missiles to be fired from helicopters and armored vehicles. There is speculation that a hot new anti-tank weapon now in user tests could win the steeplechase—and it may be causing the delay in a commitment by the Army.

mall Will Come Later

Expect the Air Force to hold off on issuing requirements for a third-generation ICBM, sometimes called "Project Small." The missile could be much smaller than *Minuteman* and more mobile; on the other hand, it might be about the same size but carry a much more powerful warhead. Or two missiles may be developed. Whatever the decision, it isn't expected to be made soon.

actical Tryout

The Navy's Patrick Henry is going several hundred miles out into the Atlantic to launch *Polaris* missiles under conditions close to the real thing. The birds also will be close to the real thing—a tactical missile sans H-bomb warhead. Telemetry will be handled by the test ship Observation Island.

INDUSTRY

What Recession?

If there's a business slump, few electronics companies say they can feel it. At the National Electronics Conference there was a general current of optimism over business conditions, with several firms predicting that fourth-quarter sales will surpass those of the previous three quarters. Profits, though, are lagging behind sales. Also on the optimistic side: Grumman President E. Clinton Towl says his company is in its most secure position ever. . . . American Machine & Foundry expects record gross profits and sales for the first nine months of the year. IBM earnings for the period are also up sharply.

Space Platform Launcher

NASA-Huntsville is asking bids by Nov. 7 on a study for an orbiting space platform to serve as a space vehicle launching complex. The launcher would be put together by rendezvous spacecraft and would be used for manned circumlunar and manned lunar landings. Technology for the system must be projected to 1967.

Raising Questions

Some people in industry (non-contractors) are openly skeptical of the Army's electronic environmental test range being built at Ft. Huachuca. They contend that the Army won't get anything out of its $23 million-plus investment.

More Mercury Delay

Very quietly, NASA has taken down the *Mercury-Redstone* from its pad at the Cape. Several capsule components have been shipped back to McDonnell Aircraft at St. Louis for minor modifications. This will probably delay the first shot of the bird until the beginning of November and push the first manned *Redstone* launch to February at the earliest—and possibly into March.

INTERNATIONAL

New German Combines

Several West German manufacturers are entering into combines designated Arge (for Arbeitgemeinschaft) to produce NATO-adopted weapons. Arge 91 includes Dornier, Heinkel and Messerschmidt; Arge 104 Nord includes Focke-Wulf, Weser and Hamburger; Arge 104 Sud includes Dornier, Heinkel, Messerschmidt and Siebel; and Arge 160—Blume Leichtbau und Flugtechnik, Weser and Hamburger.

Short's New Container

Short Brothers believes it has licked the container problem for naval missiles—both for preserving propellant life and for preventing handling damage. Its *Seaslug* for the British Admiralty is covered with skin-tight plastic, wrapped in fiberglass insulation and crated in a double steel wall, waterproof container with rubber shock absorbers.

Space Electronics Corporation is actively engaged in both creating and constructing a wide variety of advanced electronic systems vital to continued progress of the nation's missile and space programs. Significant demonstrations of this ability are two highly miniaturized systems conceived and fabricated by SEC for CalTech/NASA Jet Propulsion Laboratory. Consuming less than 1 watt each, they are the Digital Data Automation System and Spacecraft Radio Command System for the advanced lunar and deep space probe known as . . .

Ranger

SPACE ELECTRONICS CORPORATION
930 Air Way Glendale 1, California CHapman 5-7651

Inquiries from qualified scientists and engineers are invited to the personal attention of Dr. James Fletcher, president.

letters

Optics Coverage

To the Editor:

Your Aug. 22 issue with Charles D LaFond's Optics Report has been like stone in a quiet pond, causing ripples i ever widening circles as the weeks go by To those of us who have been livin Optics for many years (individually speaking, since Singer is a recent convert), i is good to see this recognition and evaluation. And the Editorial in the followin issue is an excellent follow-up to the report, a repetition of the story we hav been telling for a long time. We hope yo will continue watching Optics.

The Fall Meeting of the Optical Society of America, in Boston Oct. 12-14 will probably not pass without discussio or comments on your Report.

P. C. Foote, Sr. Optical Scientis
Singer-Bridgeport Div.
The Singer Manufacturing Co.
Bridgeport, Conn.

To the Editor:

It has taken four weeks for your issu featuring optics to filter on down to m from the engineers who insisted on marking, underlining and commenting on th entire article.

From where I sit, I can't think of better tribute to an obviously complete well-edited report on an almost neglecte subject so vital to our defense capability Congratulations!

Richard G. Farrell
Director of Public Relations
Chicago Aerial Industries, Inc
Barrington, Ill.

Map Appreciated

To the Editor:

The map of missile bases in the 1 September issue of your magazine is suc a fine job that we would like to reproduc it for distribution to our base commanders

Office of Informatio
Headquarters
15th Air Force
March AFB, Calif.

Permission granted.—Ed.

Map Corrected

To the Editor:

Hate to pick flaws in an excellen magazine, but in two issues you hav placed Dyess Air Force Base and its hos city, Abilene, in Kansas. I think the correct location is about 164 road miles wes southwest of Fort Worth.

Roy P. Huff, J
Alvarado, Tex.

To the Editor:

Reference your map of U.S. missil bases on page 41 in Sept. 19 M/R.

Since when is Dyess AFB at Abilen

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Kan.? And since when is Abilene, Kan., outhwest of Salina, Kan.?

A faithful reader,
Capt. Henry P. Ames, Jr.
Ass't AF Regional Civil Engr.
Missouri River Region
Schilling AFB, Kan.

'o the Editor:

The *Atlas* missile base at Dyess AFB ; located in Abilene, *Texas* and not Abiene, Kansas! This error has been carried hrough several previous issues also.

Dick Reid
Customer Training Dept.
Convair-Astronautics
San Diego

'o the Editor:

This is to inform you that Dyess AFB ; not at Abilene, Kansas, but Abilene, 'exas. We are enclosing your map with e correction marked on it.

Aubrey A. Wilson
Wilson Manufacturing Company, Inc.
Wichita Falls, Tex.

Yes indeed. It is unlikely that we'll ıake that mistake again.—Ed.

legulus Clarification

o the Editor:

Checking over the Astrolog in the ept. 12 M/R, I spot a slight error conerning *Regulus*. Apparently there is some onfusion between *Regulus I* and *II* KD2U-1).

Under "Contractors," *Regulus I* still ses Aerojet-General for propulsion; *Regus II* now is using Rocketdyne.

Under "Description," *Regulus I* has a 00-mile range; *Regulus II's* range is more an 1000 miles.

Under "Status," *Regulus I* is deployed oard U.S. submarines and with Fleet nits as the Navy's only operational surce-to-surface missile; *Regulus II* is being sed as a target drone in connection with e Air Force *Bomarc* program, operating ut of Eglin AFB, Fla. Chance Vought's ase of operations for this program is enice, Fla., where the Range Systems ivision has its *Regulus II* headquarters. ome *Regulus II (KD2U-1)* work also is eing done by the Navy at Pt. Mugu, alif.

Vernon B. Hobart, Supervisor
Press Information Services
Chance Vought Aircraft
Dallas

M/R's September Astrolog inadverntly identified Regulus I as Regulus II. 'e appreciate the correction.—Ed.

ntomological Conclusion

o the Editor:

The fly referred to by Dr. Parry (Soet Affairs, M/R, Sept. 26, p. 44) should designated *Drosophila melanogaster*. *rosophilidae* is the family to which it longs, not its genus.

F. S. La Roche
Lockheed MSD
Sunnyvale, Calif.

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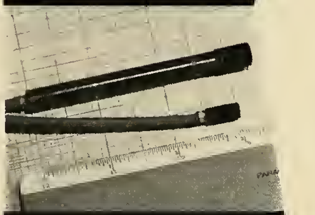

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'gigacycle spectrum' opened . . .

FCC Move May Kill World TV

Commission rejects pleas by common carriers, NASA and others that portions be saved for satellites

by Jay Holmes

THE FEDERAL Communications Commission has taken an action that may make impossible worldwide television and other commercial applications of communications satellites.

Brushing aside the pleas of scientists, common carriers and other government agencies, the FCC on Oct. 5 threw open for private point-to-point communications systems one of the last uncrowded media—the microwave spectrum above 890 megacycles.

Thus, the day after the successful orbiting of the Army's *Courier I* communications satellite, the commission rejected requests for setting aside portions of the so-called gigacycle spectrum for commercial communications by satellite.

The American Telephone & Telegraph Co., which has said it is willing to spend $50 million of its own money on launching, ground transmitters and receivers, and spacecraft for initial system of 30 communications satellites, denounced the decision as "short sighted" and voiced hope it does not cause America to lose its leadership in world communications.

The FCC decision was by a 6-1 vote. Commissioner T. A. M. Craven, in a dissenting opinion, predicted that the commission will be forced to reverse itself in a few years and dispossess entrenched business enterprises before they have time to amortize their investments.

"I fail to understand," Craven declared, "how the commission could be so short-sighted as to encourage large businesses to invest huge sums of money for the purpose of using a portion of the spectrum which space communications may need on an unhampered basis."

The common carriers—AT&T, Western Union, the U.S. Independent Telephone Assn. (USITA) and General Television Service Corp.—asked the commission to set aside several bands 500 mc wide below 10,000 mc or to defer any action releasing the gigacycle spectrum for general use. The carriers said space communications needs could not be spelled out more definitely until completion of preliminary experiments with communication satellites.

• **On horizon**—The FCC, however, decided that the immediate requirements of private users are more compelling than longer-term requirements for satellite communications. Near the close of a hearing last July, Commissioner Robert E. Lee asked one witness:

"How would you justify not using spectrum space on the theory that 20, 30, 40 years from now we may need it for something else when an important segment of our economy is clamoring for it, and maintaining that it would help them to more efficiently do their job?

The witness, Andrew G. Haley, general counsel of the American Rocket Society, replied:

" . . . There is ample evidence . . . which would indicate that it is not a question of 20, 30, 40 years from now . . . There are all kinds of uses for which we don't have the frequency space at the present time (or) that are right on the horizon, 18 months, two years, three years, four years from now."

How pressure built—Here is the background of the dispute:

The tremendous growth of communications demands in recent years is applying a relentless pressure on existing facilities. Overseas telephoning is growing even faster than the average—at a rate of 15% a year. Even with the most modern techniques made possible by application of information theory, new transocean cables are just barely able to keep up with present demands.

Laying new cables is enormously expensive. Radio in the high-frequency spectrum is unsatisfactory because it is subject to interruption by sunspots and the noise level is high. By relaying messages in the gigacycle range from satellites, both of these problems can be overcome. And the satellite, of course, makes worldwide television possible.

If R&D continues successfully over the next four years, it seems certain that direct television transmission o the 1964 Olympic Games from Japa to the United States will be possible But there is now a question whethe such a venture will be commerciall feasible.

• **TV ups cost**—AT&T told th commission it could provide facilitie for an initial system of 600 telephon circuits between the United States Europe and Hawaii with 30 satellites Charles M. Mapes, the company' assistant chief engineer, based hi figures on a cost of $30 million fo the satellite system and $2.5 millio for each of eight ground stations—creating 2400 circuits at a unit cos of less than $25,000. The most efficien overseas cables would cost substantiall more per circuit, he added.

Mapes figured that adding television to the initial network woul increase the cost of satellites to abou $60 million and of each ground statio to about $2.7 million, bringing th total cost to about $82 million.

(Presumably, the satellites woul have to be launched by low-cost *Scou* vehicles from government launchin facilities if the unit cost is to be hel below $1 million. This would mea each satellite would be held to a maximum weight of about 150 lbs. Mape did not go into these questions, however.)

The FCC took its first action Aug 6, 1959, toward allowing private industrial applicants to operate privat point-to-point communication system in the spectrum above 890 mc. However, it temporarily stayed executio of the order on Oct. 5, 1959.

Meanwhile, several parties appeale for reopening of the case in view o the changing state of technology o communications satellites. The FCC granted the request on May 16, 1960 and held hearings the week of las July 6.

In addition to the common carriers the commission heard or receive statements in favor of maintaining th stay from the Space Science Board o the National Academy of Sciences, th American Rocket Society, Directo Jerome Wiesner of the Massachusett Institute of Technology Electronics Research Laboratory, NASA Administrator T. Keith Glennan, Director Le

ORN ANTENNA of world's most sensitive radio receiver helped prove principle of assive communications relay by receiving signals from Echo balloon satellite.

. Hoegh of the Office of Civil & efense Mobilization and the Institute f Radio Engineers.

Testifying on the other side were e National Assn. of Manufacturers, the lectronic Industries Assn. and some f the individual applicants for micro- ave channels. The NAM and EIA aintained that the use of privately wned microwave systems would re- uce communications costs and effect vings, which would be passed on to e public in reduced prices.

• **Narrow bandwidths**—Another re- ted problem is the national assign- ents of frequencies by the Inter- ational Telecommunications Union TU). At the ITU's Administrative adio Conference in August, 1959, e United States proposed that 10 ands in the microwave region be re- rved for all forms of space communi- tions. The conference, however, ap- oved only eight bands.

The FCC said in its decision that is virtually impossible to allot 2000 3000 mc bandwidths for communi- tions satellites from the spectrum ace assigned by the ITU. The com- ission has asked for comments by arch 1, 1961 on what proposals this untry should make at the next inter- tional radio meeting in 1963.

The Space Science Board told the CC that the ITU agreed-upon fre- encies are inadequate for the space search program of the next decade. he board reported that NASA requirements for 10-mc band in the 900 mc area are still unsatisfied. NASA needs the band for high-definition television and Doppler shift.

Wiesner urged that the FCC defer promulgation of standards, selection of bands for satellite communications and the granting of all but the most urgent applications in the microwave region until adequate studies are made.

Hoegh called on the commission to exercise care in satisfying other services to avoid establishment of new "rights" in the gigacycle spectrum. He reported that his staff is circularizing all federal radio users to obtain the best estimates of space communication needs.

• **Plea for action**—Glennan wrote: "I am sure that the American people would be most distressed if, when the time came for the public at large to enjoy the fruits of NASA's research, it became impossible or at best economically ruinous to achieve the full potential of space exploration because of the failure of the government itself to foresee the problems and take timely action."

NASA needs wide-band channels, Glennan explained, for low-error-rate data transmission as well as for television. Generally, clear-frequency channels are desirable, he continued, but sharing may be possible if strict procedures are established for avoiding interference.

Although many applications of communications satellites have been proposed, they are not being developed by the government. Glennan declared he is "relying on the ingenuity of American industry."

The NASA chief added:

"Our position, in view of the clearly foreseeable use of communication satellites in the near future, is that adequate portions of the radio spectrum be so allocated as not to inhibit the future exploitation of this new means of improving the quality, quantity and diversity of communication."

The commission held that the total bandwidth available to private microwave above 890 mc represents only a quarter to a third of the need AT&T stated for space communications. "We cannot find that the public interest would be served by adopting a policy which would limit the growth and development of conventional microwave systems using microwave frequencies for all users," the majority said.

"If future conditions warrant a reallocation of frequencies to provide for space communications needs, we will then take whatever action may be necessary."

• **Business before space**—Commissioner Craven declared in his dissent:

"Very little imagination or wisdom is needed to recognize the terrific influence which the use of passive or active satellites in the field of space communications will have on the world. And yet, despite this obvious future impact, the commission . . . authorizes an increase in the number of private businesses which will operate individually owned microwave systems on a primary basis in that portion of the spectrum which is best suited for space communications. As a consequence . . . space communications would necessarily find itself subsidiary to such frequency users as manufacturers, banks, department stores and grocery store chains . . .

"The evidence indicates that virtually every basic industry will become extensive users of the spectrum and that electronic radio equipment manufacturers are planning a sales campaign to sell millions of dollars of radio equipment to these new users. The aggregate investment in private microwave communication systems within the next few years could amount to a billion dollars or more."

Craven maintained that the decision may "have an adverse impact upon scientific research of the cosmos" and "will intensify the difficulties in providing for the radio spectrum requirements for space research at the 1963 International Radio Conference."

FCC sources said only three applications for private microwave channels are on file now but more are expected as a result of the decision.

Countdown for Survival

Defense Issue Still Eludes the Campaigners

LETTERS ARRIVING in ever-increasing numbers at the office of MISSILES AND ROCKETS, in the wake of the M/R open letter to the two Presidential candidates, demonstrate two things clearly:

1. There is a strong and concerned interest in the defense and space issue in this country.

2. Most of those writing in believe we are behind Russia in defense and space—and that it will take money, drive and leadership to catch up.

One writer spoke of the need of an "awareness of our need to win the space race." Another wrote:

"Inasmuch as both candidates have recognized domestic problems, I believe they should state their positions relative to the scientific and defense problems, and specifically their attitudes toward space exploration."

The nine points proposed by the editors of MISSILES AND ROCKETS as providing a starting point toward capturing the lead from Russia in the defense/space race (see box) were, with some notable exceptions, regarded favorably.

Several writers pointed out what they considered serious omissions—namely, the problem of public shelters and the anti-missile missile.

• **Basic agreement**—There was general agreement on the first and perhaps major point in the M/R proposal—that the government "Recognize as national policy that we are in a strategic space race with Russia."

In Senator Kennedy's reply, carried in last week's issue of M/R, he said:

"We are in a strategic space with the Russians and we are losing . . . Control of space will be decided in the next decade. If the Soviets control space they can control earth, as in the past centuries the nation that controlled the seas dominated the continents."

One writer, Richard F. Gompertz, a member of M/R's editorial advisory board, carried the point further. Emphasizing that his opinions were his own and not necessarily those of his employer, Rocketdyne, he wrote:

"Looking at your proposed space program, I feel that you picked rather isolated projects which in themselves contradict the primary goal that you were after; namely, the establishment of *strategic programs* in space . . . There is a big step between an isolated space supremacy accomplishment and an *operational* space striking force, which I can envision would be modelled somewhat after our present SAC Air Force. I feel that any timetable should stress the operational date of such a force."

Another defense industrialist, who requested that his name not be used, had another view, writing in part:

"I would suggest as Item #1, that we recognize as a national policy that we are in a life or death struggle with international Communism and therefore must direct our efforts accordingly—this to include economical, political and defense (defense to be all-inclusive)."

M/R's Proposal

1. Recognize as national policy that we are in a strategic space race with Russia.
2. Expedite present space projects to provide a new and bold program with the following goals;
   - Manned space platform—1965
   - A U.S. citizen on the moon—1967-68
   - Nuclear power for space exploration—1968-69
   - A spacecraft which can take off from earth, travel to and in space, return and land under its own power—1968-69.
3. Recognize that "space for peaceful purposes" is possible only if "freedom of space" is ensured; hence that the U.S. military must be given a predominant role in developing and carrying out the projects necessary to guarantee freedom of space.
4. Establish pre-eminent strategic, tactical and defensive forces with representation from all services.
5. Recognize the necessity of greater defense funding to accomplish this, including a supplemental budget in January, 1961, to make it possible to:
   - Speed up to a maximum degree the construction of ICBM launching bases, Polaris submarines and the Mach 3 missile-carrying B-70.
   - Provide the Army with funds to begin the immediate procurement of already-developed modern missiles, other weapons and airlift.
6. Establish further-on defense spending by need and not by budget ceiling.
7. Streamline defense regulations and procedures to make Industry's role in the U.S. defense and space effort more effective.
8. Take what steps may be necessary to establish and promote national scientific objectives.
9. Re-establish decision-making in the U.S. defense and space organizations.

• **Candidates' positions**—As th campaign drew nearer its conclusion Senator Kennedy had contented himself with letting his reply to the M/R open letter stand as his position o the defense and space issue.

Vice President Nixon's position remained vague, although his reply t the open letter has now been promised for our next (Oct. 24) edition.

In addition to declaring that we ar indeed in a strategic space race with Russia, Senator Kennedy in his reply included in his defense/space issue stand affirmations that:

Space is our great New Frontier freedom of space must be assured an the United States must have preeminence in security as an umbrella under which we can explore; the Department of Defense must be reorganized and streamlined; he would request a supplementary defense appropriation in January; he would establish defense spending by need and not by budget ceiling; he would streamline defense regulations and procedures to make industry's role in the U.S. defense and space effort more effective

Mr. Nixon's firmest—and, so far almost his only—commitment on defense came with the Nixon-Rockefeller agreement reached just before the Republican convention. The main points

A nuclear retaliatory power capable of surviving surprise attack to inflic devastating punishment on any aggressor; a powerful second-strike capability; a modern flexible and balanced military establishment with forces capable of deterring or meeting any loca aggression.

More specifically:

More and improved bombers, airborne alert, speeded production of missiles and *Polaris* submarines, accelerated dispersal and hardening of bases, ful modernization of equipment and ou ground forces, and an intensified program for civil defense.

Later, in Detroit on Aug. 24, he said:

"We have heard that our military strength has put us now in second place. Today we can say categorically and we can say proudly that the United States is first in the world militarily.

"We must always take advantage of the new technological developments we must not be frozen into acquiring and depending upon the weapons of the past to fight the wars of the future

"At the present time we do not see any necessity of raising our taxes in order to maintain strength. But let us resolve that should the time ever come when, because of the necessity of maintaining our strength, we might have to tax ourselves more to do so, we shall put security first and the tax situation second."

Debate Warms over M/R's Proposal

)ther Objectives Urged

'o the Editor:

I have read your open letter directed
) Vice President Nixon and Senator Ken-
edy, and have briefly reviewed the nine-
oint proposal on the issues of defense
nd space exploration. I would like to
ıake the following comment:

Item #1. I personally do not feel that
e are necessarily in a strategic space race
ith Russia. In my opinion, there is much
reater danger from Communism within
ıan from any achievement or accomplish-
ıent in space. I fully recognize the polit-
al aspects of space accomplishment;
owever, I do not agree that space pro-
ams should be conducted on this basis.
would suggest, as Item #1, that we rec-
gnize as a national policy that we are
a life or death struggle with interna-
onal Communism and therefore must
rect our efforts accordingly—this to in-
ude economic, political and defense (de-
nse to be all-inclusive).

Item #2. I personally feel that we
ıve a reasonably well-planned space pro-
am and that it should be continued on
sound technical basis. I can personally
e no need for establishing goals of a
anned space platform for 1965; a U.S.
tizen on the moon, 1967-68; or a space-
aft which can take off and return to
rth, in 1968-69. I would suggest that
more productive program would be in
e development of the systems now un-
r contract, and I would add to the cur-
nt list a satellite interception system. In
y judgment, the interception and des-
uction of enemy satellites and space
stems is a must, and a program should
ıve been initiated prior to this. I agree
th your suggestion on the development
nuclear power for space—the date of
68-69 would appear to be fairly realis-
; however, I believe the date should be
tablished by experts in the field.

Item #3. I agree.

Item #4. I do not agree with the sug-
stion here which would, in my judgment,
ıd to a single service. I personally be-
ve very strongly that we need an Army,
avy and an Air Force; a single service
ould not insure the defense of our na-
n as well as the Tri-Service, operating
dependently under the Guidance of the
int Chiefs of Staff. Of course, there is
need from time to time to bring strate-
, tactical and defensive forces under
e command, but I do not subscribe to
s as a national policy in peacetime.

Item #5. I personally do not believe
at larger defense budgets or greater de-
ıse spending is the solution to our prob-
n. The retirement of obsolete weapons
systems and the deactivation of un-
cessary bases would release funds which
uld better be directed toward the pro-
rement of essential weapon systems to
ure a modern and effective military
ce. I agree with your comments refer-
ce ICBM launching bases, *Polaris* sub-
rines, and the B-70, but these are only a small portion of the whole and should not be highlighted in any national objective program. I feel that the Army should be given greater support in modernizing its equipment and its combat forces.

Item #6. It is my belief that we are, in effect, actually committing funds and resources to essential defense needs, with the exception stated in Item #5 above. Our defense spending is not necessarily controlled by a budget ceiling.

Item #7. I agree that there is room for considerable improvement in this area, and I feel that there should be a reduction in the numbers of people, located in the Pentagon—not only in the Department of Defense but in the headquarters of the three services as well. There should be more policy making at the top and less operational control. In other words, I am for decentralization—the trend during the past few years has certainly been towards centralization of control, which is not in the best interests of national defense. In the first place, it fails to develop people at the working level or instill in them a real sense of responsibility.

Item #8. I agree.

Item #9. I would like to refer you again to my comment reference Item #7.

In conclusion, I feel that your proposal should be restudied and more essential and productive national objectives established. One national objective that I may suggest, which would contribute more to our national defense than any other I can think of, would be to apply the $41 billion to the procurement of modern weapons and to training and maintenance of a modern and effective combat force. Entirely too much of the budget is spent for political reasons and used in support of the national economy instead of the national defense.

(Name withheld on request)
Maj. Gen. USAF (Ret.)

Silenced by Policy

To the Editor:

This has reference to your invitation to comment upon your open letter to the presidential candidates concerning defense and space exploration. I believe it would be inappropriate for me, as a military officer, to comment because such a comment conceivably could be interpreted in a political context by some readers.

I appreciate your invitation to participate in the discussion, but regretfully must decline to do so.

Roscoe C. Wilson
Lieutenant General, USAF
Deputy Chief of Staff,
Development

To the Editor:

I have been notified that current policy will not permit me to comment on your open letter to Vice President Nixon and Senator Kennedy. I am extremely sorry about this.

The current position is that we in the Army must be very careful to keep ourselves disassociated from political activity, at this time in particular.

Arthur G. Trudeau
Lieutenant General, GS
Chief of Research and Development,
USA

Two Fields of Effort

To the Editor:

I have read with considerable interest the editorial open letter to Messrs. Nixon and Kennedy.

I certainly agree with the aims of your proposal. However, if I had been writing it, I should have placed more emphasis on the fact that there are two different fields in which U.S. space effort is needed. The first is the field of exploration, which includes flight to the moon and so on. The second is the field of consolidation, which includes meteorological satellites and others of the "earth-looking" class. Both of these are needed.

A further thought that I am not sure should be expressed in such a letter but which I believe is valid: neither of these is a proper field for pure scientists. The first is primarily a field for explorers in the Admiral Byrd-Edmund Hillary tradition, supported by the scientists. The second is purely an engineering problem based on application of the basic discoveries made so far.

R. P. Haviland
Engineer-Satellites and
Space Systems
Missile and Space Vehicle Dept.
General Electric Co.
Philadelphia

Evils of Bureaucracy

To the Editor:

Please accept my hearty congratulations on your open letter and editorial. Being a veteran of Air Force R&D, I have tried to analyze what is wrong in the United States, why we are unable to successfully sell advanced programs to our country. In my judgment it resolves to the following point: U.S. industry, which is unsurpassed, has learned to avoid bureaucracy; the Military has not. This is abetted by the fact that the Armed Forces are using public funds, and many checks and balances are required. At least this is what has built up in practice.

In about 1900, the Wright brothers tried to sell the Government an airplane based on world-record gliding and studies they had made. The bureaucracy at that time decided to select the outstanding aeronautical engineer to handle this problem and allocated funds for his work. The Wright brothers flew their machine in

1903, still trying to sell it to the bureaucrats, waiting for Dr. Langley and the governmental approach to the problem. The Wrights took their plane to Europe and, after generating interest in Germany, England and France, were called back and given a $25,000 contract. Then in 1909, after losing six years, the Langley effort failed and the Government bought the Wright airplane. This approximates the pattern we are using today, except that today's pattern is many times more cumbersome. If we are going to cure this evil we must do two things: (1) We must eliminate all of the multitudinous staff levels and advisors, including committees, and let some one individual run with the ball. (2) The President's Scientific Advisory Board must keep the President and Congress properly educated to the desirability of advanced programs. It is tragic, but one has to laugh at the recent prohibitions against the words "missiles" and "space" and the abolition of the Air Force Office of Astronautics in the Pentagon.

J. W. Sessums, Jr.
Maj. Gen. USAF (Ret.)
Redlands, Calif.

Would Add Shelter Loans

To the Editor:

You overlooked an Item 10, which should state: Immediate Federal Aid in a Fall-Out Shelter Program . . . long-term housing loans at low rates of interest to be made available.

According to various reports—some secret, some not, such as the Rand Report, the book *Fall-Out,* and the Congressional Civil Defense report, this country is in *urgent* need of shelters. *Shelters are as great a deterrent force as SAC and just as necessary.*

E. N. Kaufman
Woodland Hills, Calif.

Takes Issue with Kennedy

To the Editor:

The Department of Defense is a hugaboo to everybody, but it is the creation of the Democrats. Sen. Kennedy's 7th point is well made and I agree. However, his other comments do not seem to quite add up properly. It does not seem to follow his platform that while their program calls for enlargement and control of vast other phases of American Enterprise, they are going to save billions by streamlining DOD and at the same time spend more money for defense. Also, from his remarks in Point 4 he apparently has never heard of NORAD.

I would like to submit that it does not stand to reason that the Democrats are the only ones interested in the preservation of America. I wonder how much your magazine, as well as Sen. Kennedy, knew of the U-2 before it hit the headlines? This was almost as closely guarded as the Manhattan Project—does this not lead you to conclude that there are others?

Your fine magazine is crammed with information on what, five years ago, would have seemed unbelievable advancements and future wonders.

It is most unfortunate that our country has been offered by the Democrats a candidate for President who is so blind to any of the superb advances that have taken place under the Republican Administration; if he is elected, I wonder just how much change he would make, or how much of it he would really want to change.

M. L. Carlisle
Washington, D.C.

MISSILES AND ROCKETS is providing a forum here to focus attention on the space/defense issue in the presidential campaign—and after the election. This is an issue which the editors feel warrants much greater attention by the nation's leaders and the American public.

Readers are invited to express their views on the vital questions of how this nation is to win the strategic space race with Russia. Correspondence should be addressed to:

Countdown for Survival
Missiles and Rockets
1001 Vermont Ave., N.W.
Washington 5, D.C.

Chicago ARS Resolution

To the Editor:

The Chicago Section of the American Rocket Society is unanimously in favor of the "Modest Proposal for Survival," and wishes to congratulate the editors for providing this public forum.

Since the Chicago Section feels that the greatest gap in the Missile Race lies in a definite lack of unified leadership and direction, the enclosed CHICAGO RESOLUTION was submitted to the Annual Meeting of the American Rocket Society, Nov. 16, 1959. Whereas M/R's proposal lists decision-making as the ninth item, the Resolution recommends that the centralization of authority be presented as the first step for survival. With proper direction of the missile/satellite program, the U.S. arsenal will be stocked with superior weapons, the deployment of which can be assigned to existing military and/or space agencies.

The problem posed by the editors is one which must be faced by the presidential candidates, and a forthright reply from each is essential if the future of the the American way of life is to be assured.

C. C. Miesse, President
Chicago Section
American Rocket Society

The text of the Resolution of the Chicago ARS Section:

Whereas the United States program of space exploration is lagging appreciably behind the Soviet accomplishments; and

Whereas there is no single government agency vested with the authority and responsibility for the total national effor

The Chicago Section of the America Rocket Society proposes the followin resolution:

Resolved: That the American Rock Society recommend to the President the United States that a Director of Spac Research be appointed, and that he given the authority, responsibility an funds necessary to establish and maintai a leading position for the United States the field of space exploration.

Amen, Mostly

To the Editor:

I submit the following *personal* con ment on your nine proposals:

1. Amen.

2. Amen, except that the time scal for nuclear power development should b stepped up. Power is the "key" to spac chemical power has severe limitations an must be replaced as soon as possible.

3. Amen! The experiment with peaceful, separate, NASA has set us bac a year or two already.

4. Concur with your goal, but th methods of achieving this are critical, you well know.

5. & 6. Amen, again.

7. Amen, as necessary, *but keep in dustry and labor influence out of decisio making processes!*

8. Amen.

9. Amen. Hallelujah!

As you have pointed out, achievemer of the above goals requires the highe type of leadership and will to succee from the highest position on down. W do not necessarily have to be buried b dirt or suffocated.

Your cause is the finest. I wis MISSILES AND ROCKETS full and earl success.

R. L. Kibbe, Captain, US
Director, Astronautics
Operations Div.
Office of the Chief of
Naval Operations
Washington

Praises Unified Approach

To the Editor:

I was sufficiently impressed by th "Open Letter" to take the time to expre my 100% agreement.

It seems to me that in dealing wit Communist Russia, where there is no re distinction between "military," "civilian," "government" or "industry" as we reco nize these terms, we are handicappin ourselves unnecessarily by trying to mak these distinctions here, even if only f world propaganda purposes.

Furthermore, I believe that a singl unified drive for world supremacy in mi siles and space would be self-financin e.g., the money saved by eliminatin needless duplication of effort could b added to the funding for the major ob jective.

J. F. Waters
Sunland, Cali

Picking Up NERV

AVY SWIMMERS from USS Rowan re shown being hauled aboard ship with he waterproof emulsion package they trieved from the Pacific last month.

The Missile/Space Week

Cancelled R&D Projects Listed

The full story of how the Pentagon spent more than $2 billion on subsequently cancelled R&D missile and other weapons projects during the last three years is expected to be disclosed by the Senate soon after Jan. 1.

A Senate Government Operations Subcommittee headed by Sen. Hubert Humphrey (D.-Minn.) gave a preview of the subcommittee's forthcoming report in a statement this last week.

Sample Comment: "The subcommittee does not at present offer any conclusions as to the original or subsequent worthwhileness of these $2.1 billion in cancelled projects. The Department of Defense would naturally contend that these projects were soundly initiated and were cancelled only when it became clear that it was in the national interest to do so."

Some of the projects named: *Navajo, Rascal, Regulus,* the F-108, *Goose, Dart, Rat,* the Sea Master and *Plato.*

NASA Plans Courier-type Satellite

The National Aeronautics and Space Administration plans to launch active repeater communications satellites, a project until now exclusively handled by the military.

Pointing to the success of the Army's *Courier I* satellite launched Oct. 4, Administrator T. Keith Glennan said NASA has programed a demonstration of the feasibility of very lightweight active repeater satellites in an orbit 3000 to 5600 miles above the earth's surface. The 500-lb. *Courier I* has a 500-750 mile orbit. He noted that security of communications is of paramount importance in the heavier Army satellite.

Glennan said NASA will team with industry on technically promising proposals aimed at developing commercial communication systems. To the extent allowed by the law, he said, NASA will make vehicles, launching and tracking facilities and technical services available at cost to private companies if the plans fit in with the requirements of other licensing bodies.

GAO Cites Reaction Motors Overcharge

The general accounting Office claims that Reaction Motors Inc., Denville, N.J., realized excessive profits by overcharges of $103,500 on a $511,400 subcontract with Convair in 1958 for propellant valves for the *Atlas.*

GAO said Reaction Motors, now a division of Thiokol Chemical Corp., provided for unwarranted contingencies and duplicate parts in its cost estimate.

Convair chose Reaction Motors on the ground of technical superiority, although its cost estimate was higher than those of competitors.

GAO said RM refunded $87,800 to Convair under these subcontracts and $47,200 under other subcontracts that it did not examine. The Congressional agency said it is pressing the Department of Defense to obtain the remaining $15,700.

Army Starts Missile Defense Studies

The Army's multimillion Field Ballistic Missile Defense System is underway with the awarding of six feasibility study contracts, totalling $1.5 million, to industrial teams. The breakdown includes Convair, Burroughs Great Valley Labs and Westinghouse Air Arm; GE and Chrysler; Hughes, NAA, Aerojet-General Nucleonics and R. G. LeTourneau; Martin and W. L. Maxson Co.; Raytheon, IBM, Dunlap & Associates, Inc., Avco and Northrop; and Sylvania with Ford Aeronutronics.

From the Pad

Polaris demonstrated its tactical ability with a 700-mile shot from the Cape Oct. 19 . . . On the next day, the first advanced-design *Atlas "E"* with a new powerplant built to carry a heavier warhead halfway around the globe, hit a programed target . . . And on Oct. 7 a *Titan* lofted an operational-type nose cone to an "unusual" height. Next week, the Air Force is giving the Smithsonian the RVX 1-5—first re-entry vehicle recovered from a 5000-mile shot.

Air Force Presses for Early Repeat of Samos Shot

First launching fails to achieve a polar orbit of camera satellite; next try may come in November

SAMOS I vehicle is hoisted onto gantry at Pt. Arguello to be mated to Agena B for range's first major system firing.

POINT ARGUELLO, CALIF.—Air Force pressure for rapid development of the *Samos* reconnaissance satellite is expected to result in a new attempt to launch an R&D model at the earliest possible date.

No firm date was immediately set, pending an investigation into why the first *Samos* launching Oct. 11 failed to place the camera-packing satellite into orbit. But some sources said another shot might be attempted next month.

Meantime, the unsuccessful test launching from Point Arguello raised anew the question of how the Russians will react to the passage of a U.S. reconnaissance satellite over the Soviet Union.

The launching took place at 12:34 P.M. PST. It was the first major launching from the Navy's new test facility just south of Vandenberg AFB.

The Air Force announced two hours later that the 4100-pound satellite had failed to go into orbit.

First stage of the unsuccessful *Samos* was a modified Convair *Atlas* weighing 262,000 lbs. at launch and measuring some 77 ft. in height including the adapter section.

The second stage was a 22-foot Lockheed *Agena A*. It weighed approximately 11,000 lbs. before launching.

The cigar-shaped vehicle was aimed at a nearly circular 300-mi. orbit with a 94-min. period. Once there it was programed to tilt so that its nose cameras would point toward earth, constantly adjusting to maintain this position.

Transmitters aboard the satellite were expected to operate for about 20 days. Exhaustion of the gas supply for the jets which maintain the vehicle in its nose-down attitude would have been another limiting factor in its useful life.

- **Some equipment classified**—In addition to photographic equipment, *Samos* carried instrumentation to measure cosmic rays, micrometeorites and the earth's electrical field.

Air Force officers declined to comment on the remainder of the *Samos 1* payload other than to state it included "test photographic equipment." An announcement at launch said the satellite was the first in a research and development program intended "to develop new capabilities for making observations of the earth."

Brig. Gen. Robert E. Greer, Vice Commander, Satellite Systems, Ballistic Missile Division, refused to list the photographic equipment aboard the vehicle. But it was made clear that the satellite would be taking photographs and that means were available to assess the quality of these photographs. Whether they were to be transmitted back to earth was not immediately disclosed.

Labor Heads to Fight Base Delays

TOP LABOR LEADERS are promising the Pentagon that they will tour ICBM construction sites during the coming weeks to help give local unions a sense of urgency in completing the Air Force's vast base-building program.

Defense Secretary Thomas Gates met with union leaders Oct. 7 at the Pentagon in the latest of his efforts to end slippage in the projects.

Gates had met previously with officials from all major contractors in the ICBM base program. At that time, he invited AFL-CIO President George Meany to attend, but Meany did not do so.

However, Meany was present along with eight other national labor leaders at the Oct. 7 session. Among the others were Nicholas Zonarich, director of the AFL-CIO industrial union department; A. J. Hayes, president of the International Association of Machinists; C. J. Haggerty, president of the AFL-CIO Building and Construction Trades Department; Gordon Freeman, president of the International Brotherhood of Electrical Workers; Peter T. Schoemann, president of the Plumbers and Pipefitters Association; and Joseph J. Delaney, president of the International Union of Operating Engineers.

Walter P. Reuther, president of the United Auto and Aircraft Workers, and David J. McDonald, president of the United Steel Workers, sent representatives.

Scores of work stoppages have cost the ICBM base program 75,000 to 100,000 man-days. Supervisory personnel have complained that many local unions failed to appreciate the importance of the program.

Work stoppages have occurred over such jurisdictional disputes as which local union should hang fluorescent lights in an ICBM block house.

Stoppages plus management snags at Warren AFB, Wyo., and Offutt AFB Neb., delayed the completion of ICBM sites up to six months, thereby affecting the nation's deterrent posture.

'Father' of the Minuteman-on-Rails

Profile of AMF's Jack Blades, prime mover in the Minuteman train concept, who wants more ICBM mobilization

DETERMINING THE FATHER of the *Minuteman* train concept may be as full of complications as a Hollywood paternity suit. In this case, however, the acknowledged father is merely a modest man who feels others should share the credit.

The railroading missile was no one-man idea, of course. But the man most generally given a large part of the credit is Jack H. Blades, manager of customer services for American Machine and Foundry, associate prime for the *Minuteman* train.

According to Blades, the idea came from a brain-storming group at AMF looking at the overall problem of mobility. AMF management had concluded that missile mobility must be a defense requirement in the near future. At the same time, the Air Force was thinking along similar lines. The concept of an ICBM on rails—capable of rapid movement over a wide area, quick reaction time, and an acceptable survivability ratio—seemed to fit well into this concept.

"Acceptance of the train idea was something less than enthusiastic in some quarters, however," Blades admits. "A few are still in there fighting new ideas."

• **Proposal for mobility unlimited**—Engineering of the mobile carrier-launcher generated some new problems, too, and strained the state of the art in some areas of rail transport. The big bird will be a pampered traveler; its delicate insides must be treated much more gently than the fussiest Pullman passenger. Development of special shock-mounting, environmental control, and the carrier-erector gave designers numerous headaches.

"All the problems haven't been solved, but the concept has been proved," Blades says. "I'm confident that the trains will be ready by the time the missiles are operational."

Blades declares that serious consideration should be given to mobilizing missiles in more ways than just on rails. He feels that an entire mobile ICBM system—based on a proven standardized missile—should be built around a number of different carrier-launchers: ships, barges, trucks. "These, coupled with fixed bases, would give us retaliatory and survival capability in depth," he says, "essential to the defense of this country."

"WE SHOULD be at work right now on a 10,000-mile ICBM . . . and missile recall."

• **On waste and duplication**—Blades is acutely conscious of dollars, unlike some that cry for unlimited spending for defense. "We shouldn't spare any money, taxes, or contributions to develop the strongest defense possible," he says, "but the defense structure warrants reevaluation to get the most for our dollars."

He is an outspoken critic of the money wasted by the military and industry in present proposal-solicitation methods. "I personally know of instances where system proposals cost up to $8 million and more. These costs, of course, go back to government in one way or another and add considerably to defense spending."

Blades advocates—as do many others—negotiated contracts awarded on the basis of demonstrated competence, so that more money would be spent on hardware rather than on piles of pretty paper.

Another of his pet philosophies is that weapon system duplication is unnecessary and costly. "After a certain stage has been reached," he says, "the military should put all developmental effort into the better system rather than continue parallel work on similar missiles. We should be at work right now on a 10,000-mile ICBM and on a method of missile recall."

Blades agrees that the principal benefit to industry from defense contracts is the research and development and know-how gained that can profitably be applied to commercial products. Consequently, he thinks that the government should give full patent protection to its suppliers. "Such protection would be the biggest thing that could be done for small business," he says.

Questioned as to the general business outlook under a new Administration, Blades is confident that the country is in "damn good shape" and there's nothing wrong with business. He feels that both Presidential candidates are aware of the necessity of an accelerated defense program for survival and looks for an upturn in defense spending regardless of who wins the election.

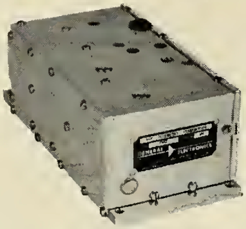
• **Engineer's manager**—Blades fits pretty well the popular picture of a self-made man. He was raised in St. Louis and, during World War II, worked there for McDonnell Aircraft. In 1943 he started his own business—Selb Mfg. Co.—building accessories, components, and equipment for aircraft. He sold out his interest in 1954 and joined AMF where he later became manager of manufacturing services. Still later he moved to Washington, into his present position as manager of customer services.

Blades is the type of competent extrovert you expect to find in such a position. In addition, his engineering and manufacturing background gives him a keen grasp of the problems and details that go into a working system. He apparently is no far-out dreamer, yet his work on the *Minuteman* train, for example, tabs him as a progressive thinker with his eye on the practical future.

About the only thing that appears to tax the competence of Jack Blades is coping with three daughters—two of whom are teenagers. ⌘

COMPLETE LINE OF VHF TELEMETRY EQUIPMENT

MANY ITEMS AVAILABLE FROM STOCK

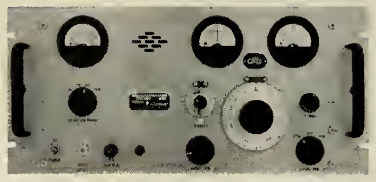


TELEMETRY TRANSMITTER, 215 – 265 mc

Improved frequency stability, true frequency modulation, reduced harmonic distortions, and increased power output characterize GEL's VHF Telemetry Transmitter, Type 15A2, specifically designed to meet the exacting requirements of present day telemetry systems.

FEATURES

- *Shock:* 100g, 11 milliseconds
- *Vibration:* 15g, 2000 cps
- *Frequency Stability:* ±0.005%
- *Distortion:* Less than 1%
- *Modulation:* FM/FM, PDM/FM, PCM/FM
- *Temperature Range:* —54°C to +85°C



TELEMETRY RECEIVER, 215 – 265 mc

Designed in comformity with IRIG requirements specifically for use in FM/FM, PDM/FM, and PCM/FM Systems, GEL's Telemetry Receiver, Type 11B1, provides a versatility heretofore unobtainable. Other bandwidths than those shown below, or special response characteristics are available on order.

FEATURES

- *IF Bandwidths:* Plug-in type, 100, 300, 500, 750kc
- *OSC Radiation:* Meets MIL — I — 6181
- *VFO or Crystal:* Operation selected by panel switch
- *Image Rejection:* Greater than 60 db
- *Noise Figure:* Less than 7 db

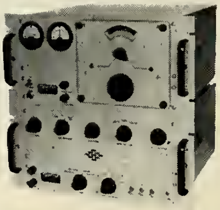
FREQUENCY DISPLAY UNIT, SERIES 14

Accepting signals from GEL Receivers, Frequency Display Unit, Series 14, features good resolution, equalization ±3 db, low spurious radiation, edge-lighted scale, and 60 db image rejection. A signal as low as 2 microvolts at the Receiver input gives full-scale deflection.

Sweep width, center frequency, and gain control are located below a 3" Cathode Ray Tube. Unit mounts in 19" Relay Rack. Series 14 Frequency Display Units are companion units to GEL VHF Receivers.

FEATURES

- Low Spurious Radiation
- Edge-lighted Scale
- Pentagrid Mixer
- Switch for Multiple Inputs
- 20k resolution
- Adjustable sweep width 0 to 3 mc



WIDE RANGE RECEIVER, 30 – 260 mc

GEL Wide Range Receiver, Type 17A1, is used in a broad variety of applications, and is designed to receive AM, FM, and Pulse information. This unit is characterized by extreme sensitivity to the reception of weak signals. The tuning head is contained in a completely shielded sub-assembly, and has very low oscillator radiation. Tuning range is covered in two bands selectable from the front panel. Panels are notched for 19" Relay Rack mounting. Power consumption is 225w at 115-230v a-c 50-60 cycles.

FEATURES

- *Input Impedance:* 50 ohm source with separate antenna input for each band
- *Frequency:* Band 1: 30-60 mc; Band 2: 55-260 mc
- *Noise Figures:* Band 1: Less than 5 db; Band 2: Less than 6 db
- *Oscillator Radiation:* 90 db below 1 mw at antenna terminal
- *IF Bandwidths:* 10 kc, 300 kc, 4 mc

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Technical Countdown

ELECTRONICS

Radar Reflectivity Reduction Studied

Studies aimed at reducing radar reflectivity of *Hound Dog* missiles are being conducted by North American Aviation. The goal is to make the air-to-surface missile less susceptible to enemy radar, so that it can sneak through to a target undetected.

P.A. Feedback Howl Eliminated

A happy note in the continuing progress of electronics is the announcement of an acoustic antifeedback circuit for public-address systems. A frequency-shift modulator developed by Bell Labs effectively eliminates the usual feedback oscillations so often encountered in large meetings—particularly those sponsored by, and attended by, electronics experts.

Direct Language Translation Predicted

Instantaneous automatic translation which would make possible telephone conversations between speakers of foreign languages is predicted within 20 years by Dr. E. G. Schneider of Sylvania Electric Products. The basic computer mechanism for automatic translation is already in existence, he said, even though it is primitive, and success has been achieved in artificially generating speech sounds.

Army Continues Work on Side-Looking Radar

An investigation aimed at solving the problems involved in the primary extraction of mapping detail from side-looking radar photography is under way at Goodyear Aircraft. The work is funded by the Army Engineer R&D Lab at Ft. Belvoir, Va.

Superpower Radar Tubes Developed

New superpower microwave radar tubes, many times more powerful than conventional types, have been announced by General Electric. According to GE, the developments were made possible by unique approaches in he fields of linear-beam and cross-field devices. Two new ypes—a "multiple-beam klystron" and an "Orthotron"—re presently in the works. Powers and frequencies are lassified.

GROUND SUPPORT EQUIPMENT

AF Contract for Biggest Communications Net

The Air Force has awarded an $11.5 million contract o Western Union for a communications network linking 00 air bases, depots, and civilian suppliers. Called the world's largest and most sophisticated wire network," the ystem will handle 100 million words per day involving gistics data, aircraft movements, air traffic maintenance, nd flight control data. It is scheduled for full operation early 1962.

pace simulator for Astronauts Designed

A manned space rotational flight simulator for investigation of the effects of satellite tumbling and spinning on tronauts has been designed by Norair Div. of Northrop orp. The trainer—to be installed at the AF School of viation Medicine, Brooks AFB, Tex.—includes a 10-ft.-ameter fiberglass ball riding on a cushion of air (See 32).

ADVANCED MATERIALS

High-Density Graphites Produced

Recrystallized graphite usable up to 5500°F is being formed in a hot-working process at National Carbon. Some has been produced with densities of 2.16, closely approaching the theoretical 2.26.

Free-Standing Forms By Plasma Jet

Almost any type of free-standing form can be fabricated through a process utilizing the plasma jet. Plasmadyne Corp. says the method insures the absence of foreign matter in the material of construction.

Plastic Case Future Sparkles

There is strong indication that the huge solid rockets of the near future will be wrapped in reinforced plastic cases. Although there's strong feeling that plastics development has some way to go, the technical problems are not considered insurmountable. The comparative low cost of plastics is likely to be decisive.

Monocrystalline Films By Deposition

Atohm Electronics has come up with a technique of depositing numerous alloys and other materials onto virtually any substrate. Designated "plasmionic monocrystalline film deposition," the process results in monocrystalline layers of conductors, semiconductors, or nonconductors as applicable.

Cheaper Titanium Will Mean More Space Use

If the price of titanium falls to that of stainless steel, it will be attractive as a substitute for space applications, says Wernher von Braun. Three major missile systems—*Atlas*, *Titan* and *Polaris*—have switched already from heavier alloy steels to titanium for vessels to store gases and propellants under high pressure.

PROPULSION

Quarter-Million-Lb. Engine in Design

Rocketdyne has an advanced model of the *Saturn* engine on the drawing boards. Dubbed H-2, the new powerplant is intended to develop more than 250,000 lbs. of thrust—giving the eight-engine booster a total thrust of more than 2 million lbs. The advanced engine would use a direct-drive turbopump, eliminating the entire gas-generator system.

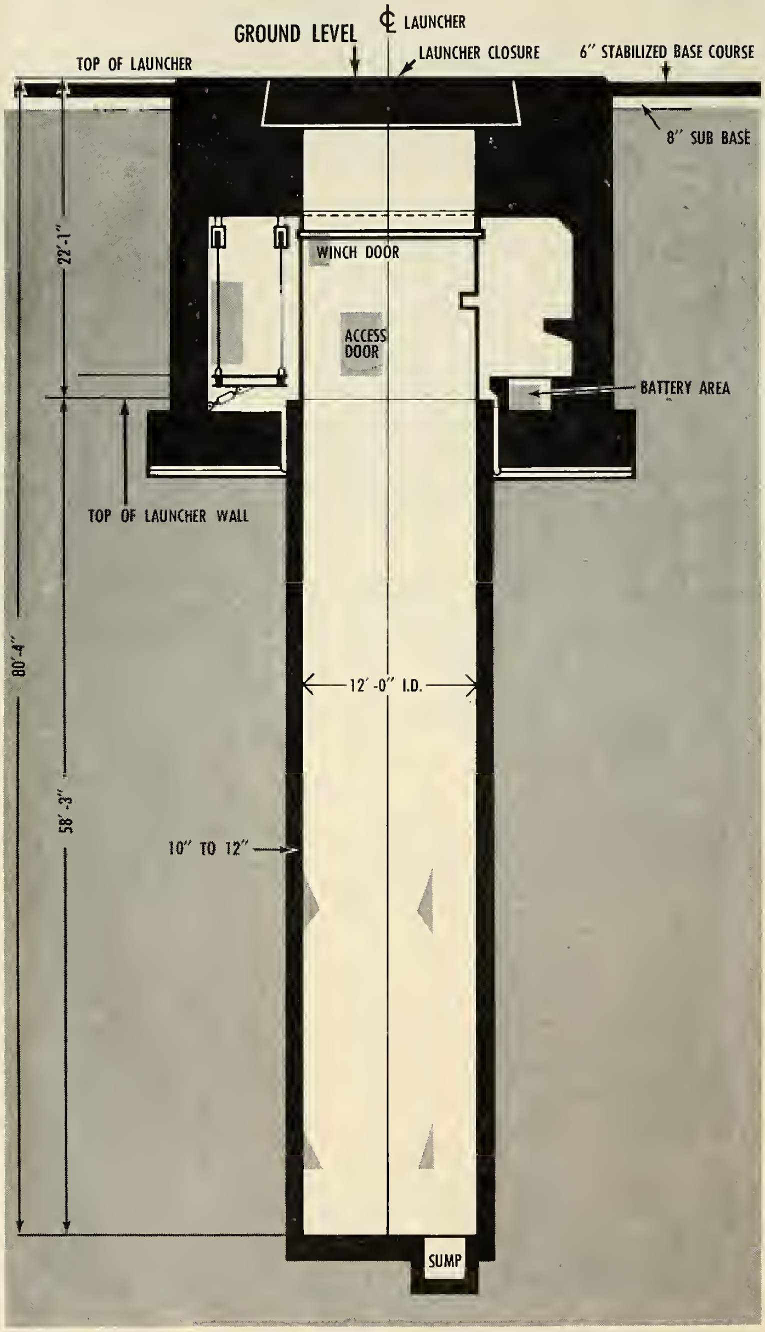
Saturn Static Tests Scheduled Sometime

Dr. Wernher von Braun has given still another date for the start of the next series of *Saturn* static tests. At a Santa Monica, Calif., press conference, he said it will be late in October. Only a week previously, Von Braun's public information office had announced the shots would be delayed until mid-November. The disparity raises a question whether there was Administration pressure to get the tests going before election.

Low-Temp Problems in Solids Solved

Thiokol reports it has solved the problem of crystallization in solid propellants at –65°F. A series of airborne launches of *Falcon* missiles at –65° has proved the propellant's reliability, company spokesmen said.

First 150 Combat Minuteman Sites



CROSS-SECTION OF Minuteman reinforced-concrete launch tube, which includes annular reinforced-concrete area for equipment.

THE 150 *Minuteman* hardene launching sites about to be built aroun Malmstrom AFB, Mont., will all b located within 115 miles of the base They will be operated by 15 launch control centers and will be completed before the middle of 1962.

Bids for constructing this $40-millon complex originally expected to g out on Sept. 23 and be opened on Nov 3. However, because of changes in design criteria, the Army Corps of Engineers has delayed the invitation dat until Nov. 4, and the opening-of-bid date until Dec. 6.

The sites are to be clustered aroun a line running approximately east-southeast through Malmstrom AFB. Mor than half of the 15 flights, designated b letters from "A" through "O," ar within 60 miles of the base; the remainder stretch out to nearly twice tha distance.

• **All-weather work required**—Indicative of the explosive, large-scal operation that will begin immediatel after the contract award is the fact tha work on the first 30 sites will be starte before the end of this year. Twenty o these sites, intended for Flights "A" and "B," are to be finished withi seven months.

Prospective contractors have bee told that because of the "nationa urgency of the project," the successfu bidder will have to make arrangement to work "unimpeded" by the seve winter climate characteristic of th region. The Army is also calling fo multi-shift operations.

Each of the 150 missile launc facilities consists of a support buildin and an underground, reinforced-concrete launch tube more than 80 fee deep. This depth includes an unde ground reinforced-concrete annula equipment area.

The launch tube is to be constructed of either poured-in-place concrete or precast concrete section Trueness to the vertical is to be withi one part in 500.

The launch tube cover will be horizontal concrete-and-steel slidin closure. Access through the closur will be by means of a hinged, hydraulically operated cover.

The support building is to be standard 12- by 24-ft., prefabricated insulated-metal building on a concret

Completed by Mid-1962

oundation. Its major equipment will e a 50-kilowatt electric generator and 10-ton capacity water chiller with air-ooled condenser.

In each of the 15 launch control acilities, a reinforced-concrete access haft will connect an underground, reinforced-concrete launch control center o an above-ground support building.

The launch control center comprises n underground reinforced-concrete apsule whose floor will be mounted on spring suspension system to relieve ibration and shock stresses. Equipment will include an oxygen generator ystem and a 5500-gallon capacity water torage tank. The support building will ontain equipment needed for feeding nd sheltering the personnel.

Any firm wishing to be prime contractor on this project must submit a Prequalification Statement" prior to ctober 28. Request forms from Corps f Engineers Ballistic Missile Construction Office, Operations Div., 9610 ellanca Ave., Los Angeles. ⁂

ITEM OF WORK	1960		1961												1962					
	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
FLIGHT A One Launch Control Center & 10 Launcher Facilities		■	■	■	■	■	■	■												
FLIGHT B One Launch Control Center & 10 Launcher Facilities		■	■	■	■	■	■	■												
FLIGHT C One Launch Control Center & 10 Launcher Facilities		■	■	■	■	■	■	■	■	■										
FLIGHT D One Launch Control Center & 10 Launcher Facilities			■	■	■	■	■	■	■	■	■									
FLIGHT E One Launch Control Center & 10 Launcher Facilities				■	■	■	■	■	■	■	■	■	■							
FLIGHT F One Launch Control Center & 10 Launcher Facilities				■	■	■	■	■	■	■	■	■	■							
FLIGHT G One Launch Control Center & 10 Launcher Facilities				■	■	■	■	■	■	■	■	■	■	■						
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FLIGHT K One Launch Control Center & 10 Launcher Facilities						■	■	■	■	■	■	■	■	■	■	■	■	■		
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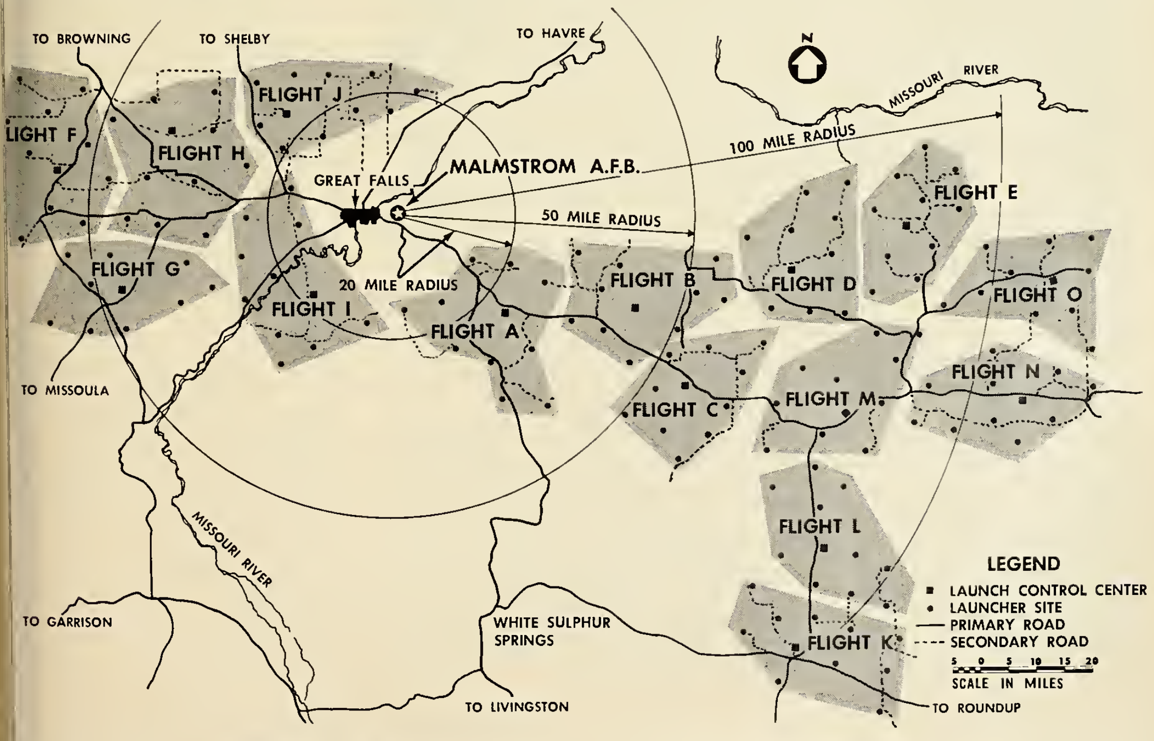
FLIGHT O One Launch Control Center & 10 Launcher Facilities							■	■	■	■	■	■	■	■	■	■	■	■	■	

Construction Schedule, 15 Minuteman Flights

EXCAVATION FOR 20 sites and 2 centers must start 10 days after the successful bidder gets his go-ahead.



AP OF ENVIRONS of Malmstrom AFB shows locations of the 150 Minuteman launcher sites and the 15 launch control centers.

GE Gyros May Solve Space Problems

by Charles D. LaFond

SCHENECTADY, N.Y.—Electrostatic gyroscopes now under advanced development by General Electric may solve many troublesome problems associated with conventional units in missile/space applications.

The new devices provide the lightweight, small-volume, and high-precision characteristics which are almost standard requisites for today's subsystems; their electrostatic suspension of the rotor assures these other advantages:

–Significant reduction in gyro drift characteristics.

–Elimination of friction and wear problems associated with conventional rotor spin bearings.

–Instant state of readiness (for missile use).

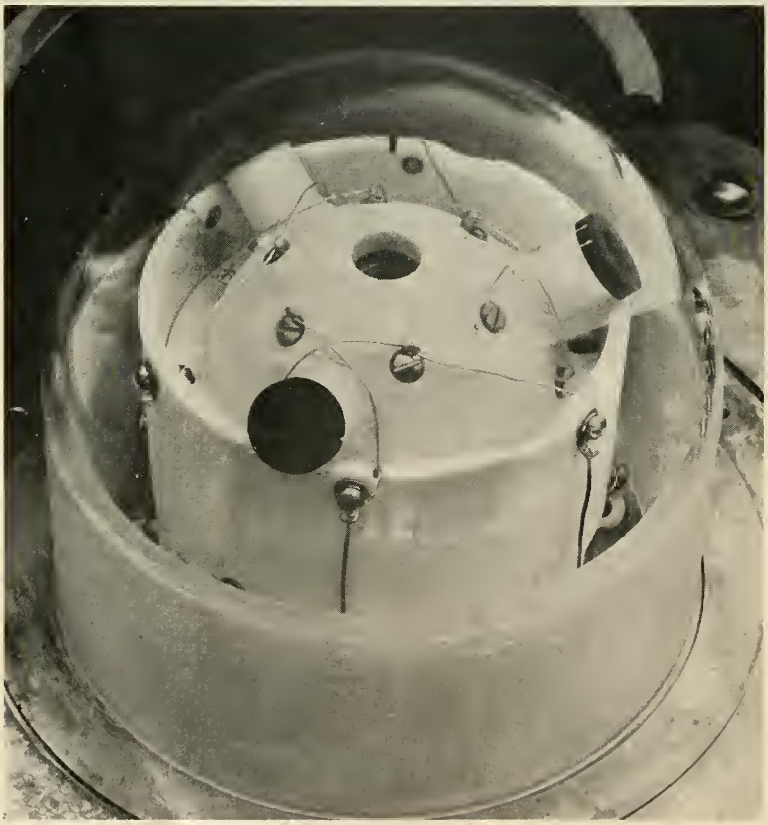
–Very low power requirements and long operational life.

–Eventual low production cost.

The gyros were developed for the Air Force by the company's Light Military Electronics Department, which is now studying their application for control mechanisms in future space projects. Reportedly, this, too, is under government contract.

• **Size will be cut**—Prototypes being tested by LMED's Advanced Engineering facility are from 1.5 to 2 times as large in size and weight as conventional gyros having the same capability. However, according to J. M. Cooper, systems engineer in charge of development, electrostatic gyros when ready for operational use will be two-thirds the size of conventional units.

Designed primarily for outer space applications, the two-degree of freedom gyros would be two-body mounted f three-axis inertial reference. No gimba would be used and the units would o erate in an evacuated housing on non-servoed platform.



ELECTROSTATIC GYRO under development by General Electric's Light Military Electronics Department has recently been tested successfully for 100 hours of continuous operation. Units show promise of unusual reliability and high accuracy for control of spacecraft.

Each gyro consists of a ceram housing in which an almost geome rically perfect metal sphere is rotate Only an electric field supports th rotor.

Warmup for a gyro requires abo 10 watts power input and about th same time needed by conventional sy tems. Average power required in a l environment would be significantly le than for conventional gyros; in spac with a near-zero g-environment, le than one-fourth of this would b needed, said Cooper.

The subsystem is designed to pr vide compensation for both norm gravity pull and ICBM g-environmen Greatest efficiency and highest pr cision is achieved, however, in a nea zero g field.

• **Drift overcome**—LMED's H. F Haake and J. D. Welch, in a paper de livered before the recent IRE Spac Electronics and Telemetry Symposiu in Washington, D.C., said that the ne gyros will offer "an inertial referenc that is orders of magnitude better, fro a drift point of view, than more con ventional gyros."

In space, they said, a vast reductio in drift rate will result from th elimination of mass unbalance (or g sensitive drift), usually considered th principal source of electrostatic-gyr drift.

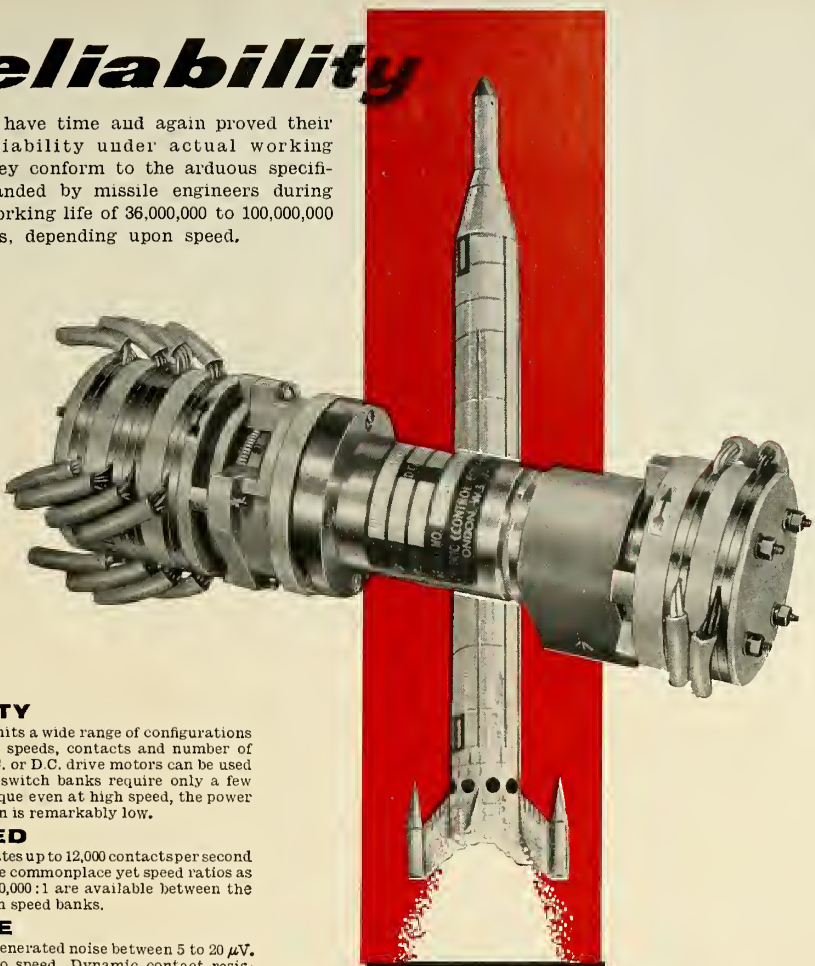
A stable platform of the type pro posed by LMED would require con ventional guidance computer tech niques. The readout system which ha been employed provides a digital in dication of the sphere spin axis relativ to the spacecraft-mounted support elec trode structure.

Optical readout techniques using a pattern on the sphere are employed Three ports are used (as shown in the accompanying photograph) to observe the rotor.

In recent laboratory tests, during which a gyro was operated successfull for 100 continuous hours, similar automatic readout equipment was employed. However, recorded data were punched in cards and then fed into a digital computer for analysis and subsequent plotting. About 1000 cards were used during the 100-hr. test to determine

Reliability

Vactric switches have time and again proved their unrivalled reliability under actual working conditions. They conform to the arduous specifications demanded by missile engineers during their full working life of 36,000,000 to 100,000,000 revolutions, depending upon speed.



VERSATILITY

Design permits a wide range of configurations in terms of speeds, contacts and number of tracks. A.C. or D.C. drive motors can be used and as the switch banks require only a few gm. cm. torque even at high speed, the power consumption is remarkably low.

HIGH SPEED

Sampling rates up to 12,000 contacts per second per track are commonplace yet speed ratios as high as 1,000,000 : 1 are available between the low and high speed banks.

LOW NOISE

Maximum generated noise between 5 to 20 μV. according to speed. Dynamic contact resistance in general better than 0.05 ohms.

COMPACTNESS

The switch illustrated has a standard international frame size 11 D.C. motor and gearhead which gives a fair indication of the compact overall size of a complex unit.

ACCURACY

High pulse positional accuracy permits units to be used with automatic de-multiplexing ground equipment.

Vactric

ROTARY SWITCHES

Vactric High Speed Telemetry Switches have been designed for the British Ministry of Aviation and used on the "Black Knight" test vehicle. The power consumption is less than 3 watts with 4 high speed tracks running at 80 r.p.s. and geared to 2 low speed tracks rotating at precisely 1/24th of this speed.

Size 11 A.C. Motor Tachogenerator

Size 10 A.C. Motor

Size 11 A.C. Synchronous Motor

Size [illegible] D.C. Motor

Size 11 A.C. Servo Motor

Size 11 Gearhead

pical examples from the vast range of Vactric International frame size 07-18 servo motors and gearheads

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gyro rotor spin axis location.

(According to its developers, the amount of computation required is inversely proportional to the complexity of the visual pattern on the rotor.)

- **Some drawbacks**—Although GE's electrostatic gyros show promise of surpassing today's proven subsystems, the new units have some undesirable traits.

Limiting factors in minimizing drift rate are steadily being reduced through continued development. These include sphericity, homogeneity of material, shielding against magnetic effects and compensation for extraneous electrostatic effects.

There is one other problem which appears to be solvable only through reliable power supply design of the suspension electronics.

If an electrostatic gyro is up to speed and a voltage loss occurs, the precision-finished surface of the sphere undoubtedly would be scored on contact with the housing. Thus the system is unusually sensitive to continue power—but so are conventional missile-borne computers.

The Air Force still has securit wraps on further details of the program. What space vehicle or satellit of the future will be first to emplo such a system also is unknown.

However, M/R understands tha GE has proposed that an advance electrostatic gyro inertial system b used in the Air Force's third-generatio ICBM.

AF Moves to Avert Command 'Crisis'

Industry and military may feel drastic effects from findings of year-long study of command and control systems

by Hal Gettings

BEDFORD, MASS.—The Air Force is taking a searching look at the vital command and control systems required to wage defensive and offensive high-speed global war.

Termed a "crisis" by Maj. Gen. Kenneth P. Bergquist, commander of AF CCDD (Command and Control Development Division), failure to properly define and implement adequate command and control systems could cause the U.S. to lose command of its weapons systems—and lose a war.

Revolutionary advances in the destructive power of weapons and in the speed and range of delivery systems has created this "crisis." The extreme quantity and abstract quality of data, the compression of decision time, and the necessity for rigid central control to avoid accidents, have imposed this crisis on the operational commanders.

First task in charting this new course was assigned by the Secretary of the Air Force to a so-called "Winter Study Group." The WSG—made up of 139 top scientific and technical people from military, government, industry, and consultant organizations—spent year on the problem. A senior scientifi guidance group, headed by Dr. A. G Hill of Mitre Corp., monitored th effort.

Findings and recommendations coming out of the study have just bee presented to AF Secretary C. Dudle Sharpe. Briefings to industry and military groups affected by the recommendations will follow shortly. If thes are put into action widespread effec will be felt by all those concerned i building and operating C&C systems.

Basic task of the WSG was to "ex

Major Winter Study Group Recommendations

- Existing, or planned, command and control ("L") systems must be realistically appraised as to requirements, costs, and objectives of each system.
- A central strong major planning and analysis activity must be constituted to assure systems integration and develop plans and concepts covering all facets of command control problems. This central agency should:
  - –Have full responsibility and authority for making C&C design decisions.
  - –Contain a strong activity to develop standard operational techniques for command centers.
  - –Provide command centers with continuous technical assistance on costing, timing, and availability of alternate systems.
  - –Provide technical aid to command centers in setting requirements and in performing experimental work.
- More attention must be given to strategic choice* before money is invested in sensor systems.
- Great emphasis must be placed on surviving attack and controlling reaction.*
- Aggressive steps should be taken to assure full understanding between conventional support system and C&C systems of the future.
- Too little emphasis has been given to commo means of effecting timely communications betwee various components of the command centers (intelligence, operations, planning, materiel).
- Steps should be taken to obtain, train, and retain sufficient personnel to operate the C&C system and centers.
- The SPO (System Program Office) concept o systems management should be expanded to cove all aspects of the C&C problem as an aid to the command centers.

"Strategic choice" relates to the choice between quic reaction and survivability, which has a crucial effect on requirements for C&C systems. It involves the "first-strike" capabilit of launching retaliatory missiles before enemy missiles hit, a well as "second-strike" capability to follow up after attack. quick-reacting force requires a highly reliable, high-data-rat C&C system that can be soft-based. A second-strike capabilit based on a hardened force requires a system which could surviv with the force and control it. There is concern lest C&C system fall somewhere between these two positions—being neither fas and reliable enough to permit a quick strike before being hit b a surprise attack nor survivable enough to control reactio after being hit.

mine critically and objectively—from technical point of view—the entire omplex of existing and planned Air 'orce command and control systems. 'his includes an examination for techical realism of the needs and objectives f the individual AF operating eleients, as well as a study of the probms associated with the integration of ie various systems."

• **Machined decision**—In future igh-speed global war, decision-makers iust have machines to help them evalu:e enemy action and take the required efensive and retaliatory counter-action. plit-second decisions based on a mass f information—rapidly changing and ith global consequential effects and onsiderations—is beyond the scope of ian's brain.

What machines do we need to acomplish this task . . . how should they e built . . . what common language iould they speak . . . what should they ost . . . and who should be responsible or determining these things? These are ie questions that must be answered, id these are the answers the Air Force pursuing.

There are really four categories of quipment involved in command and ontrol systems: command, control, ensor, and support. As a group, these ystems comprise the machines necesary to gather data on an enemy attack, rocess, evaluate, transmit and display to a decision-maker in a form which ould enable him to decide to retaliate time to send firing orders to his orces. These are the so-called "L" sysms, such as 416L (SAGE), 433L veather observation and forecast), 6L (Space Track), 474L (BMEWS), UDET, *Samos/Midas*, etc.

At the beginning of its study, WSG ok a hard look at the L systems in ing and planned. At first, the group nsidered making detailed recomendations as to the use, feasibility, d possible modifications of these stems. It soon appeared, however, at the task was much broader in ope.

The group decided that, individuy, most of these C&C systems appear meet present stated requirements d are technically feasible. Coltively, however, they fail to pass onceptual, integration, and costing teria." In other words, they are sufient for the job they were designed , but not for the job that's coming.

Probably the most significant fact ought out by the study was the lack compatibility of these systems. Alough $10-15 billion would have been ent for such equipment over the next years, there would still be no over- "system of systems" to do the job. ch is designed as an individual tem without necessary correlation between them. It was evident that vital data could exist in some one machine while a needing command would not know of its existence or where it could be located. The different machines talk different languages, and translations require time that may not be available. (An analogous situation is the growth of individual telephone systems in this country. Without certain standardization and compatible equipment, today's rapid and simple telephone communications throughout the country would be impossible.)

It is this compatibility—or lack of it—that gave rise to the "crisis in command" evaluation.

• **C^2 D^2 bids for task**—As a natural corollary, it followed that compatibility cannot be achieved without a strong central planning and design—or management—agency. WSG strongly recommended such an agency, and apparently, this responsibility will be centered at AF Command and Control Development Division and its associated "Hanscom Complex."

In addition to CCDD, this group at L. G. Hanscom Field includes the Air Materiel Command Electronic Systems Center, MITRE Corp., MIT'S Lincoln Laboratory, and other AF strategic, tactical, and support operations. Rome Air Development Center is also considered a part of the Complex. Hanscom Field is the center for all the Air Force's electronic communications systems.

According to Gen. Bergquist, CC DD is ready to assume this responsibility and is actually at present performing many of the management agency functions. Last week he presented the WSG report to the Air Force, along with his estimate of its recommendations, and briefed the concerned commands on what CCDD is doing and can do to implement the central management agency.

'Pedigreed' Resistors

TRAYS CONTAIN high-stability metal-film resistors which will join the growing list of "pedigreed" parts for Minuteman. Manufactured by International Resistance Co., they must meet a reliability objective of 0.0004% per 1000 hours operation—that is, one failure in 250 million unit hrs. IRC has announced its $1.7 million contract for these resistors with North American Aviation's Autonetics Div., associate prime for Air Force Minuteman ICBM guidance and control system.

Goldsworthy Named First Minuteman Base Activator

Col. Harry Goldsworthy has been named the first *Minuteman* site activation task force commander, in charge of activation at Malmstrom AFB, Mont.

The announcement was made by the Air Materiel Command in San Francisco as the Air Force publicly unveiled for the first time the operational configuration of the Boeing *Minuteman* solid-fueled ICBM.

Goldsworthy was formerly with the Strategic Air Command as deputy wing commander at Malmstrom.

CROSS COUNTRY MOBILITY through STICKY MUD • SNOW AND ICE • SAND • up 60% GRADES • over WATER OBSTACLES

TRACKS MOVE WHERE NOTHING ELSE CAN GO

Modern concepts of battlefield tactics require a high degree of ground mobility for many new weapon systems. Whatever the requirement – missile transporter launchers – radar or communication equipment – ground support equipment – cargo vans – troop transport – all can have full mobility with one or more standard military vehicles of the new M113 family.

This family of vehicles in either armored or unarmored versions is lightweight to be airborne, amphibious to swim water barriers, tough and dependable for continuous heavy duty.

Test data is available on request concerning the shock loads transmitted to missile systems being carried under the most severe cross-country conditions.

Put your mobility questions to FMC, since 1941 a leading designer and builder of military standard vehicles.

For further information, write on company letterhead to Preliminary Design Engineering Dept., FMC Ordnance Division, P.O. Box 367, San Jose, Calif. Phone CYpress 4-8124.

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION
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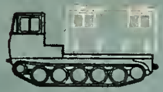
fmc

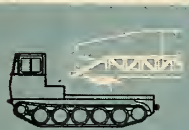
Illustrated below are the M113 and five vehicle adaptations of this basic tracked vehicle. All of the vehicles use the same military standard equipment, including engines, power train, and suspension components; thus reducing the military logistic burden and R&D costs in weapons systems.

M113 Armored Personnel Carrier

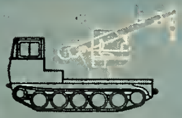
Radar Vehicle



Van-type Vehicle



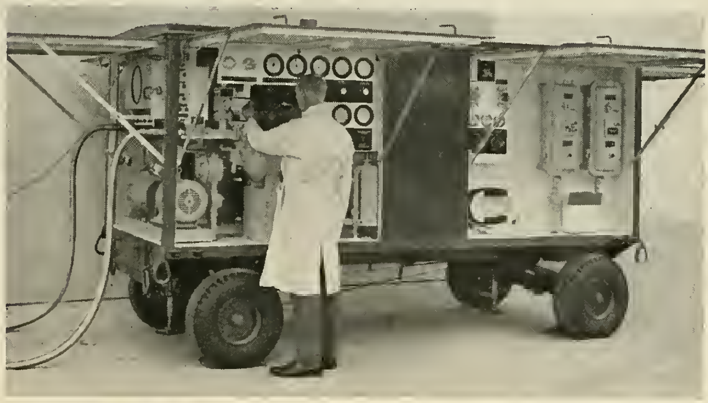
5th-wheel-type Prime Mover



Utility Crane Vehicle

Missile Launcher

FMC's New Liquid Propellant Metering System Achieves Accuracy to ±0.1%



Mobile metering and control unit for fueling liquid propellant missiles.

The crucial reliability of multistage missiles is influenced by the accurate measurement and delivery of liquid propellant to the missile tanks. For example . . . a small error in fuel weight could adversely affect the in-flight performance of the missile, causing possible failure of the entire mission.

Food Machinery and Chemical Corporation's Ordnance Division has recently developed a mobile liquid propellant metering and handling system which promises to solve many missile fueling problems. The advantages offered by this unique new system are many.

Accurately measures and records the amount of fuel delivered to the missile tanks. Original specifications called for a metering accuracy of ±0.2%. Extensive tests, recorded by precision test equipment, show that the system is capable of metering and delivering missile propellants with far superior accuracy—to ±0.1%.

Automatically compensates for factors influencing fueling accuracy. The fuel is continuously sampled and the flow corrected for variations in temperature and density. In addition, the fuel which vaporizes in the missile tanks is returned to the system, condensed, measured, and an equivalent amount added by the metering unit.

Adaptable to many different missile fuels. The system is designed to handle such storable liquid propellants as hydrazine, nitrogen tetroxide, Dimazine® (UDMH) and nitric acid.

Economical to manufacture and safe to operate. To reduce development, manufacturing and operating costs, the system makes maximum use of standard, interchangeable, and commercially available components. The simple and safe design eliminates human errors and danger to operating personnel.

Mobile and compact. All metering, pumping and control equipment is mounted on a single, portable trailer. The complete unit may be easily transported, rapidly positioned, and provides a single station for the monitoring of fueling operations.

The successful development of this mobile metering and handling system by the engineering staff of FMC's Ordnance Division is another achievement made possible by utilizing the unique combination of chemical and mechanical engineering talent available at Food Machinery and Chemical Corporation.

AIA Forecasts Striking R & D Grow

AEROSPACE research and development during the next decade will probably see doubled interest in ultra-high and super-high radio frequencies, sharp increases in human factors activities, and nearly $80 million per year spent on simulation devices.

These are some of the conclusions reached by more than 200 research and engineering experts who cooperated in preparing the Aircraft Industries Association's seventh "Forecast of Technical Requirements." Other forecasts:

–Reliability requirements will create redundant, adaptive and self-correcting systems.

–For high-temperature operation, pneumatics will take over many functions now fulfilled by hydraulics.

–For panel displays, electro-luminescent light will be used.

–Operating range of hydraulic fluids will increase to the spread –50° to 850°F, but no single fluid will take care of the entire range.

–For the next five years, high-yield alloys (to 350,000 psi) will be available only in sheet and bar form.

–In sheet forming, the predominant development area will be explosive or high-energy forming.

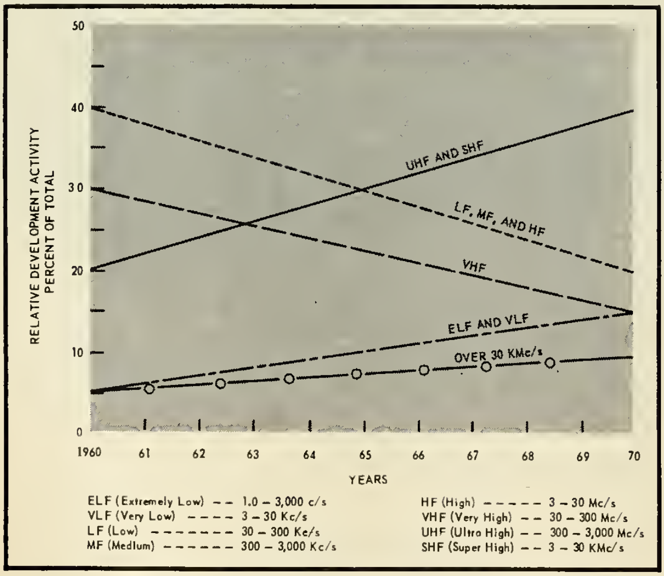
–Uses of numerical tape control will rapidly extend to lofting, draftin test inspection and systems checkout.

–Fixtures or dies for explosive wel ing to be developed for production us

–Size and complexity of test equi ment will rise about 300%.

The 92-page AIA document co siders most technical areas—exotic e vironments, systems, equipment, m terials, manufacturing processes, an testing. Oddly enough, the propulsio area is omitted.

The following charts are taken fro the AIA document, and the interpret tions are based on the association forecasts.

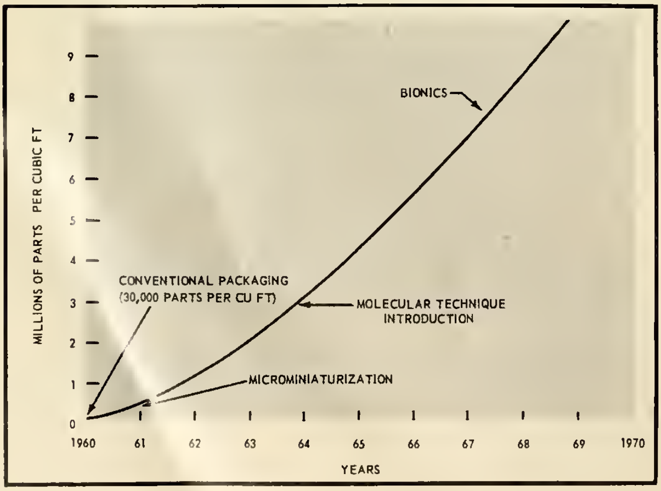


Communications—Operating Frequencies

INCREASED ACTIVITY is expected i the 1000 to 10,000 megacycle range of th radio frequency spectrum. Reasons: (1) Thi range appears best for piercing the ionospher and for minimizing atmospheric attenuatior (2) There is a need for higher data rates i telemetry and data links.

The crowded radio-frequency spectrur and the requirement for secure and privat wireless communication will bring increase attention to (1) transmission at very low fre quencies (below 30 kc), (2) use of the eart as a communications system, (3) modulatio of waves in the visual and infrared range and (4) use of "bounce" techniques fro natural or artificial reflectors, for exampl satellite mirrors.

In money terms, it is unlikely that ther will be a decrease in any activity. An overal increase is anticipated in spending for developments in communications.



Electronic Maximum Density Trends

MICROMINIATURIZATION will becom a large-scale industry within the decade.

The maximum parts density of curren airborne electronics is about 30,000 parts pe cubic foot. Welded module construction wil increase this number by about 60%, whic marks the best compaction with conventiona components. True microminiaturization begin with vacuum-deposited resistors, conductors and compacitors with microsized transistor as the active elements. Serious production o such microminiaturized or ½-million-parts-pe cubic-foot equipment will begin next year Semiconductor (molecular electronics) cir cuitry with an even higher parts density wil follow closely. After this, a new technolog such as bionics—lifelike systems—will probably be developed.

the '60's

Data Storage, Processing and Display

THE QUICKENING need for high payad-to-gross-weight ratios will see reduced omputer size, weight, and power requirements espite simultaneous requirements for more ata handling and faster computing. It appears iat one contribution to the solution will be ie development of new types of components, otably the tunnel diode and the variable ipacity diode.

Urgently needed during the '60's are large-ipacity, inexpensive, storage devices that are nall yet readily accessible for readout. As ny components are developed, two major oblems are: connecting the components, and quiring random access to the stored bits of formation. Research will also have to be onducted on expanding the multiple uses of omputer parts.

Human Systems

A TWOFOLD or threefold increase in huan factor personnel will be required by 1970 cope with the problems of human existence d performance under increasingly severe vironments and in ever more complex stems.

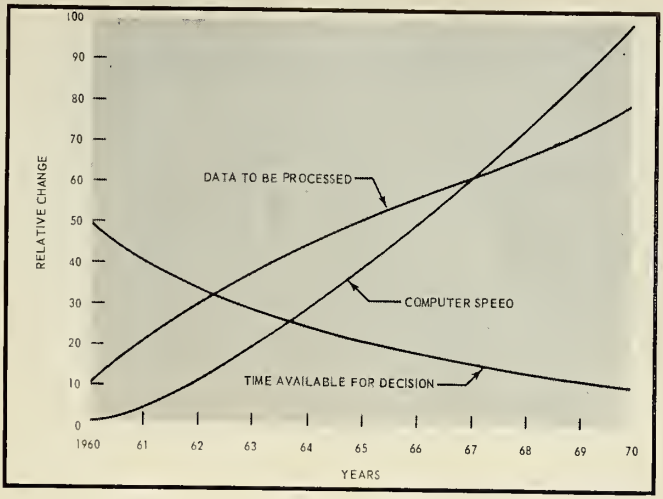
Major effort will be applied to problems escape/survival and the performance of erators as components within systems loops. more modest effort will be devoted to basic search in human capabilities and limitations; e trend is to determine these capabilities ly within the context of specific systems.

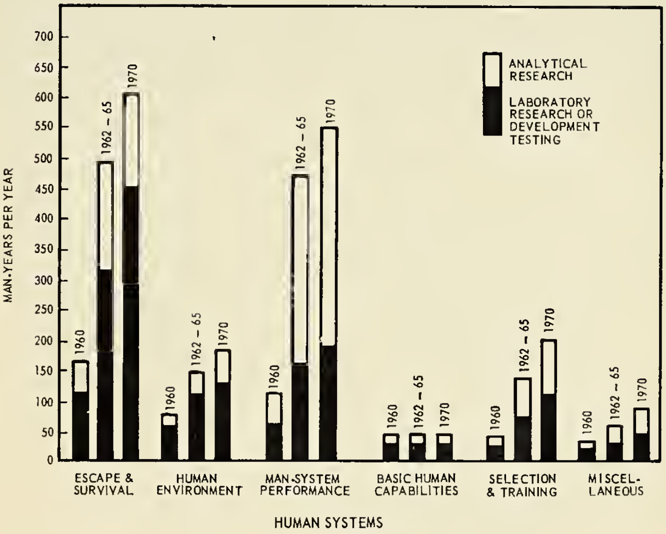
Simulation Facilities for Man-Vehicle Evaluation

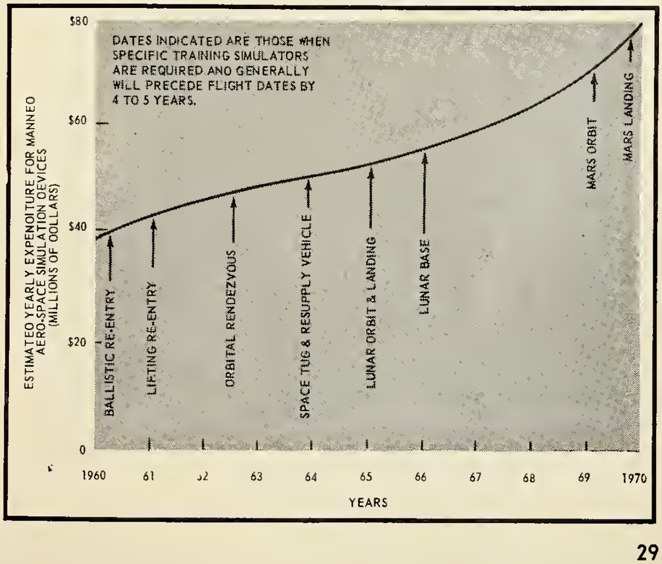
THE PRESENT annual expenditure of apoximately $40 million for aerospace simulan devices may be expected to double over the xt ten years, as flight training becomes more pensive and an increasing number of manned ace flights are programed.

Considerable data are available on man's rformance and capability under individual esses, but very little is known about his rformance under combined stresses such as ise, vibration, acceleration, high temperature d isolation. Since man's performance cant be expressed adequately for analytical lutions, real-time flight simulators are needed r study and design phases of vehicle develment—up to and including complete misn flights.

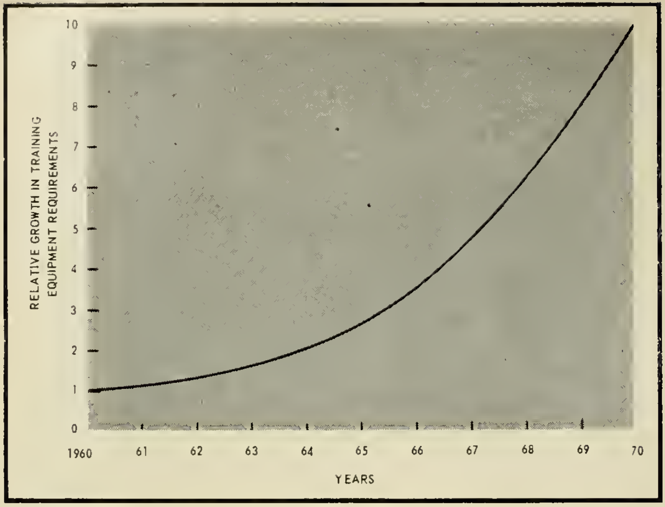
(Continued next page)

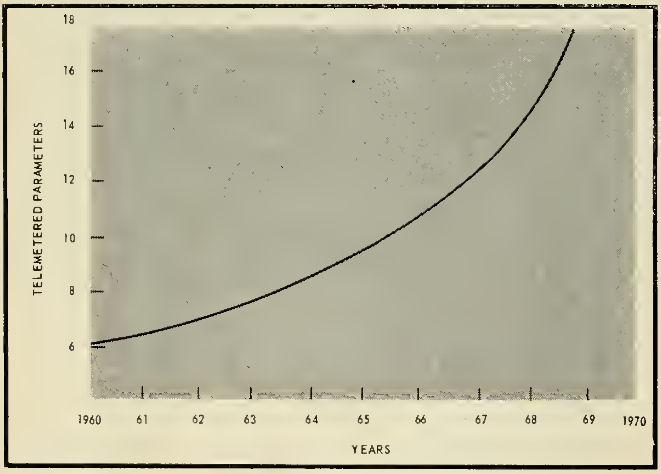


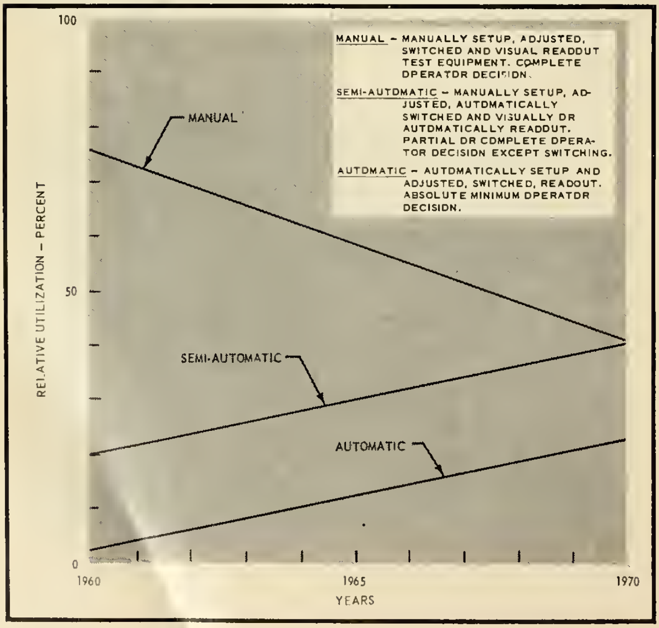



DATES INDICATED ARE THOSE WHEN SPECIFIC TRAINING SIMULATORS ARE REQUIRED AND GENERALLY WILL PRECEDE FLIGHT DATES BY 4 TO 5 YEARS.

(Continued from preceding pag







MANUAL – MANUALLY SETUP, ADJUSTED, SWITCHED AND VISUAL READOUT TEST EQUIPMENT. COMPLETE OPERATOR DECISION.

SEMI-AUTOMATIC – MANUALLY SETUP, ADJUSTED, AUTOMATICALLY SWITCHED AND VISUALLY OR AUTOMATICALLY READOUT. PARTIAL OR COMPLETE OPERATOR DECISION EXCEPT SWITCHING.

AUTOMATIC – AUTOMATICALLY SETUP AND ADJUSTED, SWITCHED, READOUT. ABSOLUTE MINIMUM OPERATOR DECISION.

Training Equipment—Man in Space

DEVELOPING TRAINERS for spac flight will be receiving a tremendous impetus a we enter the new flight regime. Such trainer will require much originality and diversity o function. Electronically generated displays an control stimuli will be used to provide clos precision and reproducible-stimulus systems fo space vehicle simulators. There is a growin trend toward using digital computers to describe the dynamic equations of motion, bu the requirement most often expressed is fo analog-to-digital and digital-to-analog conversions to permit simulation of complex fligh characteristics with high fidelity.

Biological Factors—Bioinstrumentation

FOR EXTENDED space flight, instrumentation that permits the astronaut to know at al times what is happening to his atmosphere i very important. These data must be telemetere to the scientists on earth. Environmental factor that require constant monitoring include barometric pressure, partial pressure of oxygen an carbon dioxide, concentration of noxious gases temperatures, radiation intensity, humidity an air movement.

The welfare of the individual can be determined by constant monitoring of oxygen an carbon dioxide in expired air and by hi heart rate, body temperature, blood pH an pressure, respiratory rate and volume, galvanic skin response, electroencephalogram and electrocardiogram. The major problem is designing transducers that are acceptable to the crew member and do not restrict his natural movements or responses.

Automation of Manufacturing Test Equipment

THE INTEGRATION of many complicated subsystems into a weapon system establishes a new requirement—rapid checkout. Automation was previously dictated by volume production and cost reduction. Today, however, it has become increasingly necessary to compare test data with standards at a rate that cannot be attained physically. If done manually, the volume of tests required would severely impair operational availability of the weapon system. Therefore, manual test equipment use will decrease, and automatic test equipment will increase correspondingly.

ockheed Uses Converted rawler for Ocean Studies

A 50-foot steel trawler has been onverted into a basic research vessel or oceanographic studies by Lockheed's California Division.

The former Puget Sound underwent modification at a San Diego shipyard. First trial runs were conducted n mid-September.

Lockheed expects to use the ship or detailed analysis of the ocean's urface and underwater temperature ariations, tieing in with the company's ntisubmarine research activties.

Large enough to accommodate all iecessary research and navigation quipment, and also provide living uarters for eight crewmen and scientists, the ship has a 12½-foot beam, -foot draft and fully loaded displacement of 70 tons.

A winch, utilizing Lockheed-developed electrical controls, will carry nore than three miles of conducting able—permitting ASW specialists to robe far beneath the surface for instrument readings and water samples. he Lockheed research ship's 3000-gallon diesel fuel capacity is sufficient r two-month cruises—and a range of ıore than 6000 miles.

perry Gyro Employees eject AFL-CIO Agents

Engineers and technicians at Sperry yroscope have ousted the local AFL-CIO engineers union as their bargaining gent by a vote of 1724 to 1509.

More than 90% of the eligible oters in nine Sperry plants participated n the National Labor Relations Board lection. The action was initiated by nore than 1100 employees in the 3486-member EA-IUE Local 445. The 1100 nembers represented more than the 0% necessary to call for a decertification election.

The group had for 14 years been epresented by the Engineers Association. but recently voted to affiliate with ie IUE-AFL-CIO, which already had vo locals for Sperry factory workers.

The Decertification Committee harged that "although the existing A-negotiated contract for engineers ad provided the right to vote on affiliation questions to everyone in the bargaining unit, the union refused to cognize that provision and held two ections restricted to union members."

The Committee also said that professional engineers, constituting only a y percentage of the 400,000-member JE, would be forced to accept union als inconsistent with their own best terests and that the EA union actually longer represented a majority of the rgaining unit.

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This remarkable liquid chemicals kit for the 23-109A is described in Bulletin CEC 1629-X3. The kit contains concentrated developer and stabilizer solutions in throwaway envelopes — eliminates mixing, handling and irritating odors.

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NASA Names Life Sciences Advisers

Committees drawn from broad range of industry, military and universities will meet several times during year

The National Aeronautics and Space Administration has asked 28 outstanding scientists in the fields of Life Sciences to assist that office in its program.

The advisory group will be divided in three committees, corresponding to the organization of the NASA Life Sciences Program, according to Dr. Clark T. Randt, director. Each committee will meet three or four times a year.

The experts are:

- **Space Biology** (molecular biology and cellular environmental physiology, and extraterrestrial life): Dr. Melvin Calvin, Chairman, Professor of Chemistry, U. of Cal.; Dr. Philip Abelson, Geophysical Laboratory, Carnegie Institution of Washington; Dr. Sidney W. Fox, Oceanographic Institute, Florida State Univ.; Dr. Norman H. Horowitz, Prof. of Biology, CalTech; Dr. Henry Linschitz, Dept. of Chemistry, Brandeis Univ.; Dr. C. S. Pittendrigh, Dept. of Biology, Princeton; and Dr. Carl E. Sagan, Dept. of Astronomy, Univ. of California.
- **Space Medical and Behavioral Sciences** (Neurophysiology and psychology, metabolism and nutrition and cardiovascular and respiratory physiology): Dr. Robert S. Morrison, Chairman, Dir. Medical and Natural Sciences, The Rockefeller Foundation; Dr. Frank A. Beach, Prof. of Psychology, Univ. of California; Dr. Webb E. Haymaker, Chief, Neuropathology Branch, Armed Forces Institute of Pathology; Dr. Robert Livingston, Director of Basic Research, National Institute of Mental Health, NIH; Dr. George A. Miller, Dept. of Psychology, Harvard; Dr. Nello Pace, Prof. of Physiology, Univ. of California; Dr. Stanley J. Sarnoff, Chief, Laboratory of Cardiovascular Physiology, National Heart Institute, NIH; and Dr. Stewart G. Wolf, Jr., Prof. and Head, Dept. of Medicine, Okla. Univ. Medical Center.
- **Flight Medicine and Biology** (experiments in the space environment and biotechnology): Dr. W. Randolph Lovelace II, Chairman, The Lovelace Foundation; Adolph Bialecki, Head, Chemical Engineering Section, R&D Dept., Electric Boat Co.; Lt. Col. Joseph A. Connor, Jr., MC, AF, Chairman Aerospace Nuclear Safety Board, Div. of Reactor Development, AEC; A. Scott Crossfield, Chief Engineering Test Pilot, North American Aviation, Inc.; Brig. Gen. Don D. Flickinger, MC, AF, Assistant for Bioastronautics, Hdqrs. ARDC; Dr. Robert Galambos, Chief Dept. of Neurophysiology, Walter Reed Army Institute of Research; Capt. Clifford P. Phoebus, MC, USN, Director of Astronautics, Bureau of Medicine and Surgery, Dept of the Navy; Dr. Hennig von Gierke, Chief, Bioacoustics Branch, Biomedical Laboratory, Aerospace Medical Division, WADD; and Dr. Alexander C. Williams, Senior Project Engineer, Engineering Project Management, Hughes Aircraft Co.

SAE Life Papers

Cabin Instrumentation, Survival Gear Stressed

Two papers presented at the recent Society of Automotive Engineers meeting reflect the growing interest in engineering for life sciences.

Convair's R. B. Wilson told delegates to SAE's National Aeronautics Meeting that design of cabin instrumentation may be one of the most important aspects of the engineer's contribution to manned spaceflight.

For psychological reasons, he pointed out, it is very important that the crew has reliable, easy-to-read instruments.

Since adjustments in the life support system will probably be made manually in early voyages (to save weight), it is essential that the crew be constantly aware of cabin pressure, temperature, and condition of the atmosphere.

Wilson points out that any new instrumentation should be carefully and extensively tested to gain the confidence of the crew.

In another paper, Norair's E. A. Smith and R. W. Connor call for an "early emphasis" on disaster survival techniques in interplanetary voyages.

Emergency survival should be part of mission planning as well as vehicle design, the team charges.

Smith and Connor blasted the presumption that payload weight for a Mars flight—life support system for several men and laboratory research equipment—could be kept down to about 70,000 lbs.

Survival redundancies will always be costly, they point out, but they will also be essential.

Missions which can justify a fleet of vehicles offer the best survival potential for the crew, they note.

If this is impractical, the best approach is to have the astronaut "stick with the ship" rather than try to fit him out with smaller escape vehicles.

Their reasoning is that in the parent vehicle he will have the benefit of the communications system, reliability of subsystems, radiation protection and propulsion, even if he has to drift for years.

A secondary vehicle designed with all these features, plus a life support capability of 300 days, could easily weigh over a million pounds—obviously ruling out the 70,000 lb. payload.

Some basically different design techniques will be necessary if the philosophy of "on-board survival" is employed. The Norair group proposed a compartmentalized cabin, with areas which can be jettisoned in event of damage, or closed off if contamination occurs.

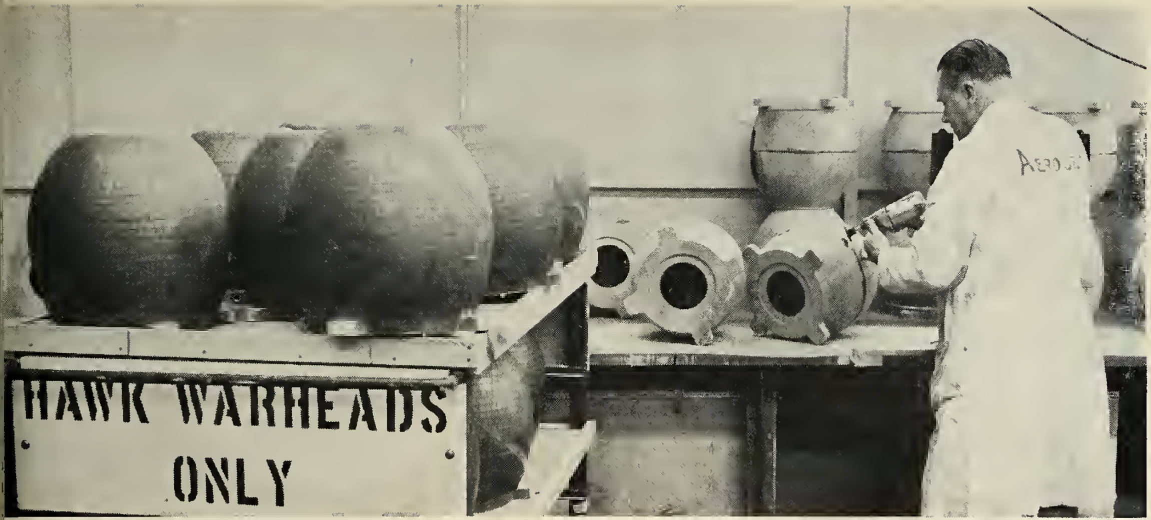
Fiberglass Ball to Spin Astronaut at 'Record' Speed

A 10 ft. fiberglass ball which will spin man almost as fast as a pre-war phonograph record is being constructed by Norair Div., Northrop Corp. for the School of Aviation Medicine.

Designed to simulate satellite tumbling and spinning, the device will permit study of man's ability to withstand extreme rotational conditions—up to 70 rpm. This will double the ability of current simulators.

The 4300-lb. vehicle will be constructed of bonded sandwich-type fiberglass honeycomb. It will ride smoothly on a circular stream of air six feet in diameter, also making it relatively noiseless.

Three inertia rings rotating within the inner surface of the sphere will provide control and rotation. The rings, powered by 20 horsepower motors, will be mounted on the axes of roll, pitch and yaw. Existing simulators are based on mechanically controlled gimbal systems.



OT-SHAPED HAWK WARHEADS are formed on an inner plastic shell which melts with heat of detonation. Center is filled with onventional explosive. Steel slugs on outer surface form shrapnel cloud on explosion.

How Hawk's 'Business End' Is Made

Aerojet wraps steel slugs around plastic shell containing explosive to form grenade-like warhead that has already scored missile kills for Hawk and Nike

NER PLASTIC BODIES are cast in form of attached hemis- eres (on shelf in background). These are separated, then tops d bottoms cemented together. Hollow shell is then wrapped th tape and covered with metal slugs.

SURFACE OF WARHEAD is smoothed prior to final painting. Dome shape is designed to produce most effective "shot pattern". These and similar warheads were used in recent successful missile kills by Hawk and Nike-Hercules.

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Flight Model OAO Coming in 2½ Years

FIRST FLIGHT MODEL of ASA's Orbiting Astronomical Ob- rvatory *(OAO)* is scheduled for de- very within 2½ years under a $23- illion contract won by a Grumman ircraft-Westinghouse team.

If the R&D work proves successful, ASA plans follow-on procurement of *AO's* that may bring total expenditure $100 million over the next decade.

Westinghouse Air Arm, Baltimore, ill provide electronic and stabilization uipment under subcontract to Grum- an. The amount of the subcontract as not specified, but it was under- ood the sum would be just under lf of the $23 million. The Grumman- estinghouse team was chosen from bidders.

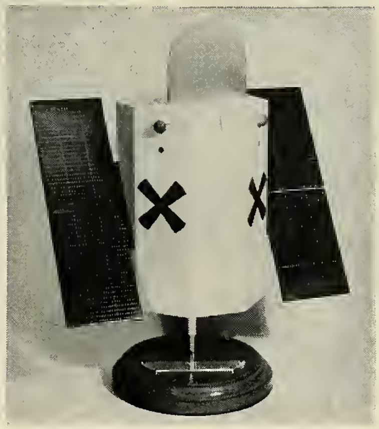
The first 3200-lb. satellite is to be livered in 2½ years for launching in e 1963 aboard an *Atlas-Agena B* ve- le into a 500-mile orbit from Cape naveral. Grumman proposes a satel- le in the shape of an octagonal prism, ½ ft. tall and 6½ ft. in diameter, ich will carry 1000 lbs. of experi- ental equipment.

• **New eyes for astronomers**—Use an orbiting observatory will open an tire new era in astronomy. Knowl- ege of the cosmos has been limited to t received through two "windows" the electromagnetic spectrum—one nprising visible light, infrared and r ultraviolet, and the other in the lio portion. The remainder is ab- bed by the earth's atmosphere and not be detected at the earth's sur- e.

Telescopes mounted in the satellite l be used to view the cosmos by X- , ultraviolet and infrared. Presum- y, later experiments may call for ervation through very low-frequency io and gamma radiation, also masked the atmosphere.

First experiments will concentrate the so-called Lyman-alpha ultra- let radiation, with wavelength 1100 A gstrom units, which is the primary nance of the hydrogen atom. Ly- -alpha measurements from sound- rockets conducted by the Naval R earch Laboratory in the last few rs have developed revolutionary s about the structure of the galaxy, icularly in the relatively near con- ation of Orion.

• **Room for varied experiments**—St ilization, power and telemetry in- ments will be fitted into a standard- shell, leaving space for variable e riment modules. The telescopes, reflecting mirrors of diameter up to 6 in., will be mounted in a central drical chamber.



OCTAGONAL form shows in model of NASA's Orbiting Astronomical Observatory, to be built by Grumman and Westinghouse.

The stabilization system will have fine pointing control able to track a star with an accuracy of a tenth of a second of arc—about the equivalent of looking at a basketball 500 miles away.

Pictures will be transmitted to ground by television to verify the direction in which the satellite is pointed. A ground command system will point the satellite, operate system and experiments, verify commands it receives and store them for execution up to two hours later.

Solar cells on two paddles will provide 350 watts of power.

At least 100,000 bits of information from experiments will be stored in a memory for later reading. Several large dish antennas will be built at NASA Minitrack stations to track the OAO radio beacon, command experiments and receive telemetry.

• **Heavy work schedule**—These experiments are among those planned for the OAO:

–An ultraviolet map of the sky, proposed by the Smithsonian Astrophysical Observatory, with the use of several 8-in. telescopes, each coupled with a video tube.

–Measurement of the ultraviolet brightness of the stars, proposed by the University of Wisconsin.

–Use of a 36-in. mirror to study emissions from a wide range of celestial bodies, proposed by the NASA Goddard Space Flight Center.

–Study of cosmic dust and gas by observing them against the stars with a 24-in. mirror and spectrometer, proposed by Princeton University Observatory.

–Spectrographic examination of the sun, proposed by Harvard University.

Tiros II to Report to 22 Stations

Cloud-cover photographs to be transmitted by *Tiros II* will be sent and received from 22 stations on the U.S. Weather Bureau's National High Altitude Facsimile Network.

Alden Electronic & Impulse Recording Equipment Co. of Westboro, Mass., under a Weather Bureau contract, is adapting facsimile weather map scanners to handle the cloud photographs.

Alden said *Tiros II* will be launched later this month. The bureau will prepare cloud-cover analyses based on the satellite data and transmit them regularly.

By having the photos shown in geographic orientation, Alden said, forecasters at network stations will be able to study in detail the actual cloud systems associated with weather activity.

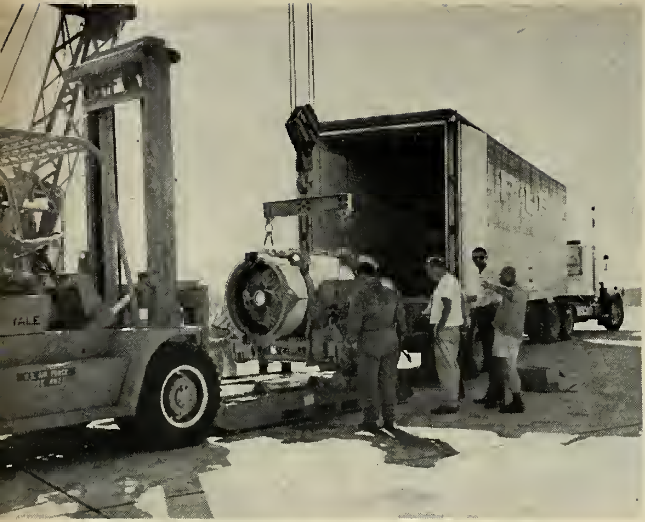
Alden said all its scanners in the field, totaling more than 300 on several weather map networks, can be adapted to handle photograph copy by substitution of one plug-in component.

The Weather Bureau first sent out cloud-cover diagrams—which it called NEPH analyses—as an experiment on May 25 with the use of *Tiros I* data. They showed cloud conditions in a band across the United States, Canada and part of the Pacific Ocean.

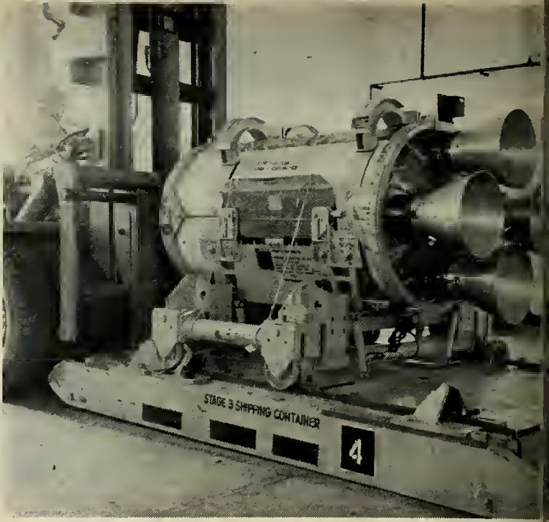
• **Frequent reports**—Alden said the television camera on *Tiros II* will be able to receive specific instructions, such as orders to focus its camera on suspected storm centers above heavy air. Fully translated weather reports will be available every two or three hours.

Four stations on the weather network—New York, Miami, San Francisco and Suitland, Md.—will be capable of both sending and receiving. Signals will be received by Boston, Philadelphia, Glen Burnie, Md., Ft. Monmouth, N.J., Arlington, Va., Romulus, Mich., Chicago, Franklin Park, Ill., Kansas City, New Orleans, Kenner, La., Burbank, Calif., Alameda, Calif., Naval Air Station, Portland, Ore., Seattle, Fort Worth, El Paso, Denver and Los Angeles.

The satellite data will be received by stations at Evans Signal Laboratory, Ft. Monmouth, and Point Mugu, Calif.



THIRD STAGE is lifted from truck during transport to Cape. Note Blowout ports in forward bulkhead, to terminate thrust.



PLASTIC-COVERED third stage is prepared for shipment Bachus. Nozzles and actuator arms for swiveling are visib

Minuteman 3rd Stage Is Big Advance

Hercules Powder Co.'s Spiralloy case combined with double-base propellant called major jump in high mass ratios

BACCHUS, UTAH—Design of the third-stage propulsion system for the *Minuteman* ICBM constitutes a major step forward in industry efforts to achieve extremely high mass ratios in rocket motors.

Hercules Powder Co.'s design, successful entry in the drawn-out competition for the third-stage production contract, utilizes a Spiralloy case and a double-base propellant giving extremely high specific impulse and temperatures over 6000° F.

Thrust termination on the motor is provided by blowout ports on the side of the case, about a foot forward of the aft end. These ports direct gases forward during the termination phase and effectively equalize forward thrust. This unusual feature enables the range to be more accurately controlled and programed. Four similar ports are located on the forward dome of the casing.

• **90% cheaper**—Spiralloy has been under development for 10 years at the Young Development Division of Hercules, and is claimed to have the highest strength-to-weight ratio of any known material. The case, with a constant wall thickness of about one-half inch, costs approximately 1/10 as much as a pure titanium case, and has a higher tensile strength.

The six-ft.-long rocket motor case is helically wound of continuous glass fibers, impregnated with an epoxy resin, and has a very small volume of metal parts constituting 45% of its total weight, not including nozzles. End domes, blowout ports for thrust termination, attach points, and exhaust nozzle fixtures are all integrally wound into the case structure.

Hercules says it can wind the cases to within ± .005 in. in diameter, with a capability of machining the case length to specification. Winding in the metallic fixtures for the case, the company can maintain ± 3 minutes of angle.

After winding and curing of the case is completed, a silica-filled rubber-based insulator is applied to the internal walls of the case. This insulator can withstand about 350°F during operation, and for the final ½ to 1/3 second of burning time, it protects the case against the combustion temperature. At this point, burnout occurs in the motor, even though the guidance system has already terminated effective thrust forward.

• **Classified coating**—As one Hercules engineer put it: "During the last second of combustion, when the burning propellant surface is approaching the case wall, the entire motor glov as brightly as a light bulb."

Steel nozzles used with the mot are coated with a non-eroding substan before firing of the motor. Nature the coating is classified. All four nozzl pivot during operation for thrust vect control, moving on one axis, as is t case of the other two stages.

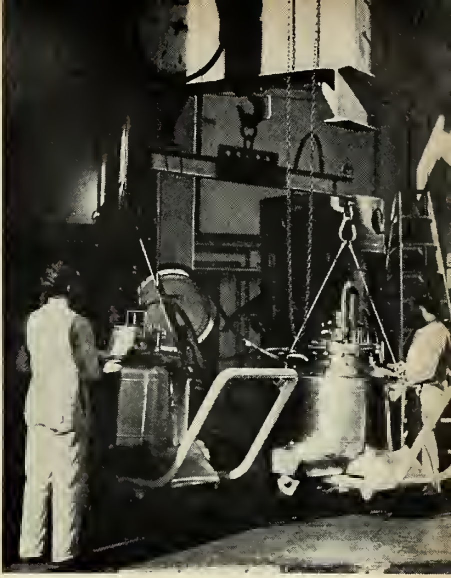
Most of the production work c the *Minuteman* third stage will be do at its Bacchus plant, the company say with the base grain powder being pr duced at the Rocky Hill, N.J., plan Nozzles, actuators, igniters, safe/ar devices and similar hardware will l sub-contracted.

Hercules says it has successful fired about 200 solid-propellant moto of various sizes using the Spiralloy cas including a number of *Altair* uni which have performed well in spa probes.

Quality acceptance tests for t Spiralloy case are about the same as f a metallic case, Hercules says, noti that quality of the case has improv 100% in just the past year, throug experience with working with the m terial, various winding patterns, ar other variables of the material.

Hercules has a number of machin for producing the case simultaneousl

PTICAL CHECK OF nozzle port alignment is made on third stage's Spiralloy ase. Ports can be integrally wound into case with accuracy within 3 minutes of angle.



PROPELLANT is poured into third-stage case in a batch mix operation.

nd curing is done with heat lamps.

• **Modification within week**—"One f the wonderful things about this ethod," William Bogart, Chamber De-elopment Supervisor says, "is that we eed no big presses, forges, heat treat urnace, or other metalworking mahinery. We use a frangible mandrel uring forming, we can use heat lamps r an oven for curing, and there is praccally no limit to the size pressure vesl we can produce."

Bogart said Hercules has proposed 5-million-lb. solid rocket booster to ASA, using the segmented approach ith a Spiralloy case. The case would wrapped on the launch site.

Pointing up the advantages of this pproach, Bogart said a Spiralloy case n be loaded and fired and, within a eek, Hercules could reduce the firing ta, crank in design changes, and have modified case ready for testing. A nilar cycle on a metal case would ke months, he said.

During fabrication, the fibreglass ving is applied in bands about one ch wide, giving a final product with strength-to-weight ratio of 1.8 million. ydrostatic burst pressure on the cases s averaged 550 lbs. to date.

• **End closure problem solved**—The st prevalent problem with filamentund cases has been the retention of ed closures in the final product. Young velopment Division of Hercules, rking on the problem, decided that t tensile strength of a filament-reinfced structure would be high, with rpect to its other properties. Indicati was that the end closures should, ossible, be retained by fibers in pure tsion.

The company vetoed a number of scemes before determining that winding fibers along a helical path on a cylindrical surface and reversing these over a spherical end zone would properly retain end closures while still stressing the filament in tension only. A simultaneous indication was that the load on each fiber would be constant whether the load was generated by end retention stresses, or radial pressure within the cylinder.

To transform filaments of glass and epoxy resins into a useful structural material required that the designs be applicable to other than perfectly balanced cylindrical structures. Also, the unit must have acceptable strengths in shear, bearing and compression—although these need not be as high as tensile strength.

The two most desirable properties are determined by two features of the final structure; tensile strength of the bonded fibers and interlaminar shear indicating bond strength.

• **Quality through numbers**—Consistency in quality has been pointed out as one of the advantages of the Spiralloy case. Visual inspection of a unit may indicate its quality to be poor, but in tests, the unit will show up less than 10% below quality on normal cases.

The consistent quality is laid to the fact that all the fibers in the case are drawn into the structure under tension at correct location, leaving no chance for folds or poor distribution to develop.

There are so many filaments in the structure at any particular location that it becomes statistically impossible for a significant number of low-quality fibers to become superimposed and lower integrity of the case.

In some instances, it is necessary to introduce a "doubler" to the design so that localized areas may have higher strength. The doubler is formed by winding filaments locally on the cylinder from an independent source. It may be wound simultaneously with the helical winding of the primary casing, or consecutively. The first of these, the integral doubler, is most effective due to its intermeshing with the primary fibers. In the *Minuteman* case, this type has been applied to the retention of end closures.

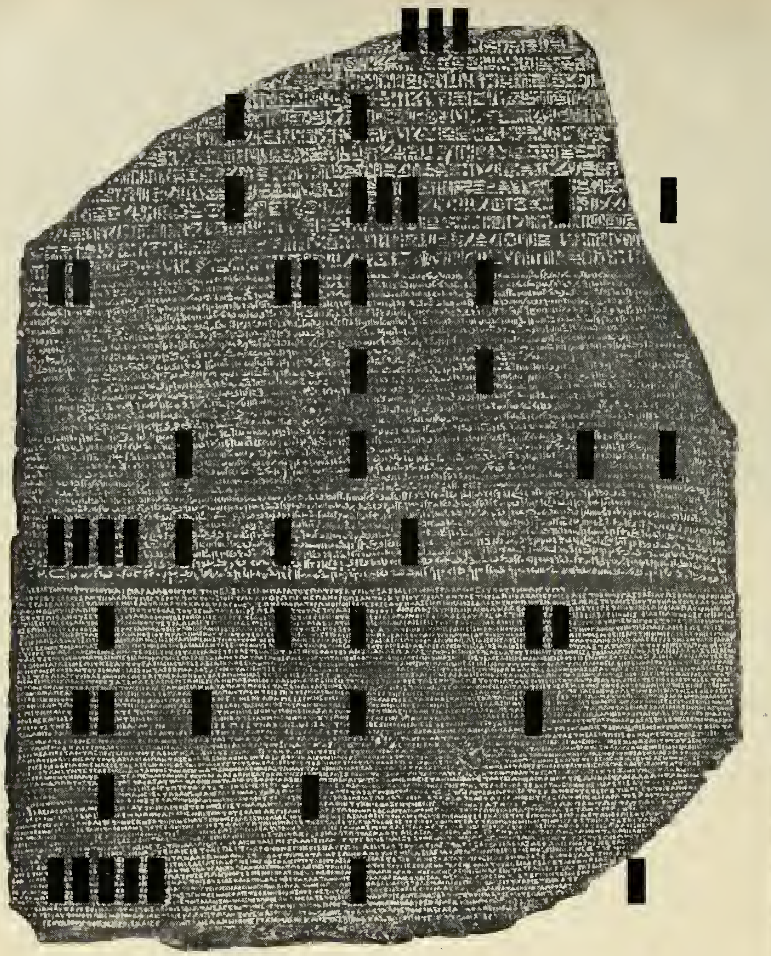
The ovaloid end profile used in the case is difficult to arrive at mathematically, Hercules says, and an analog computer was programed to set up the required diameter ratios and external forces to derive the winding curve correctly.

• **Methods of analysis**—The company says there are two systems of analyzing the Spiralloy type structure—a method considering the fibers a netting system sustaining only primary loads while the resin sustains secondary loads; and a system considering the structure as a homogenous material, with physical properties in various directions relative to the winding pattern.

High-temperature operating conditions are limited to the type of resin employed in fabrication of the case.

The case is corrosion-resistant, one quarter the weight of steel and needs no special tooling or expensive plant equipment to produce. Its physical properties are excellent—and it is cheap.

The future of the Spiralloy case seems bright. Hercules has proposed a second-stage *Minuteman* case of the material, and says it could even be applied to the first stage, if necessary. ⌘



The Rosetta Stone unraveled secrets that had been buried for centuries. It bridged the gap between known civilization and unknown, ancient Egypt. The discovery of the Stone was an accident, one of those curious events that sometimes happen. ¶ Modern science faces a language problem much more complex than deciphering of hieroglyphics. And once again a Rosetta Stone is needed. But science cannot wait for an accidental discovery. ¶ Each branch of science has its own language which it uses to state problems. But electronic computers can solve problems only if they are posed in the language of the specific computer. Translating science languages into computer languages is enormously costly in time and money. UNCOL (Universal Computer Oriented Language) is a possible solution. The development of UNCOL will bridge the gap between a multitude of Problem Oriented Languages and an increasing number of Computer Languages. UNCOL is one task which occupies scientists at System Development Corporation. ¶ **SYSTEM DEVELOPMENT CORPORATION.** A non-profit scientific organization developing large-scale computer-based command and control systems. Staff openings at Lodi, New Jersey and Santa Monica, California.

SDC

11-169

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—expansions—

IBM has disclosed plans to struct a 150,000-sq.-ft. product deve ment laboratory for Poughkeepsie, N Construction will begin next month completion expected in late 1961. Poughkeepsie center is home STRETCH, the world's most powe computer, and employs 10,000 pec

NEFF INSTRUMENT CORP. moved to larger facilities at Du Calif.

NORDEN DIVISION, (United craft Corp.) Data Systems departn will occupy its new engineering-rese and manufacturing facility at C Mesa, Calif., on Oct. 17. The ne constructed 50,000-sq.-ft. facility house the department's 200 emplo working in leased plants and lab tories at Santa Ana and those form located at Gardena, Calif.

MOTOROLA SEMICONDUCT PROD. has reorganized its nati sales network to insure technical pro service to the semiconductor field. January, 1962, Motorola expects have more than 80 sales representati account supervisors, and product cialists in the field to provide exten services.

AIRCRAFT ARMAMENTS, I has acquired B&F Instruments, a Ph delphia electronics and electromech ical instruments firm, in an excha of stock.

DRESSER INDUSTRIES' boar directors unanimously approved purchase of Podbielniak, Inc. Chicago company manufactures cen ugal solvent extractors, laboratory f tional distillation apparatus and pa aged distillation plants. Dr. Walte Podbielniak, who organized the in 1928, will continue to direct company's activities and further te nical developments.

TASKER INSTRUMENTS CO has begun operations in its new he quarters at Van Nuys, Calif. A 36,000-sq.-ft. building houses engin ing laboratories, environmental facilities, production and adminis tion activities. An additional 64, sq.-ft. production facility is planned the electronic design and produc company.

ROBINS INDUSTRIES CORP. formed a new research and devel ment division at Flushing, N.Y. Rol supplies record and tape-care ac sories for hi-fi and industrial uses.

Japan's Missilery Beset by Troubles

Industry leaders plead for stronger backing from government; public strongly opposes any nuclear weapons

by Frank G. McGuire

TOKYO — Japan's missile industry leaders are begging their government to take a firm and positive policy on defense.

Budget cuts, realignments and shifts in emphasis from month to month are harassing the planning departments of government and industry alike, a group of industry leaders has charged.

Without firm government direction, say members of the Guided Missile Association, the industry will remain in the dark about policies, future trends and business climate in the field.

Some of the snarls in the program:

–The defense program ranks lowest on the budget priority list. It's first to go when the economy axe falls.

–Japan has no plans for nuclear weapons. Not only is it barred by law from possessing nuclear weapons, but Japanese public opinion is violently opposed to them.

–It has money for a 25-mile test range at Niijima Island, but left-wing opponents and island residents have successfully blocked its establishment.

–Despite "close liaison" with Japan Defense Agency, U.S. Army Headquarters in Japan said it had never heard of JDA's most advanced missile project.

–The program is entirely open, ince Japan has no security law, and hus there are no military secrets.

• **Nuclear weapons**—An undertandable revulsion toward nuclear warare has prompted the Japanese people o react violently to the presence of uch weapons on their soil or in their rmed forces. Demonstrations occur hen a U.S. vessel, suspected of being uclear-armed, arrives in a Japanese ort.

The designation "Japanese Self Deense Force" is taken seriously. No ffensive weapons of any great range re included in inventory.

Japan hopes to avoid being accused t having any nuclear capability, and onsequently to be spared as a target event of war. Even nuclear weapons esigned to defend cities—such as the *ike* series or *Bomarc*—are not wanted.

American forces with nuclear weapons for the present are based in Korea, Okinawa, Formosa or other less sensitive nations. When Japan's attitude will change is extremely hard to predict; military planners hope that by 1970 the current "education program" will have its effect, and defenses based on nuclear weapons will be acceptable to the Japanese.

• **Domestic designs**—Of the nine missiles intended for the Self Defense Forces, five are American and four will be developed and produced by Japan. The inventory will include *Nike-Ajax* missiles with *Nike-Hercules* ground and guidance systems, *Hawk*, *Tartar*, *Bomarc* and *Lacrosse*.

Domestic production will include an antitank missile, *Mat* (TATM-1); a dual purpose unguided rocket for airborne use against aerial and ground targets; an infrared-guided air-to-air missile; and a radar-guided air-to-air missile. It is expected that all except *Bomarc* will be in use by 1965.

Mat, the most advanced missile in JDA's development program, will probably be in use by mid-1962. The original mid-1961 date slipped during the development of an advanced high-explosive warhead.

Kawasaki Aircraft Co. has been awarded a half-million-dollar preproduction contract for *Mat* and has produced from 400-500 test versions since the program began four years ago. Japanese sources told M/R that JDA hopes to have the U.S. Army and Marines evaluate the weapon for possible use in Asia and elsewhere.

However, when queried about the missile, Army Headquarters in Japan said it has never heard of the program although it has "close liaison" with JDA. The U.S. Military Assistance Advisory Group backed up this statement.

• **Dual-thrust missile**—*Mat* is a wire-guided weapon using a dual-thrust solid-propellant rocket motor developed by Dai Nihon Celluloid Co. The motor provides both boost and sustainer propulsion. A high-explosive warhead is under development by Osaka Metal Co.

Mat will be guided by means of wire control operated by a two-man team. Two gyroscopes powered by solid propellants will afford excellent accuracy, JDA says. Gyros are being produced by Tokyo Keiki Co., and the complete guidance system by Kawasaki and Nippon Electric Co.

The control system uses buttons on

NAME	1962	1963	1964	1965	1966	REMARKS
MAT*	●	—	—	—	→	Thirteen batteries
LACROSSE				●	→	One battalion
HAWK		●	—	—	→	Two battalions
NIKE	●	—	—	—	→	Four battalions
TARTAR	●	—	—	—	→	Three DDG's
BOMARC					? ●→	Perhaps HE Warhead
AAR*	●	—	—	—	→	Mighty Mouse Type
ASR*		●	—	—	→	Mighty Mouse Type
AAM* (IR)		●	—	—	→	Sidewinder Type
AAM* (Radar)		●	—	—	→	Falcon Type

*Japanese Design, Development and Manufacture.

JAPANESE MISSILE program as presently planned, including estimated dates of the nine birds, of which five are American and four will be produced in Japan.

a control box in the hands of infantry operators, rather than the more common joystick arrangement. The missile has a conventional design, using standard metal materials. It has a cruciform wing configuration and is generally similar to the French *SS-10*.

Because of high costs of certain components (such as gyroscopes) in Japan, the *Mat* is expected to cost slightly more than the *SS-10* (less than $1000). Contributing to the higher expenses will be a limited production rate —unless Japan can sell the weapon in foreign countries.

Also under development by Kawasaki is a training simulator, in both basic and advanced versions, using an analog computer and a visual display device.

C. Itoh & Co., Ltd., one of Japan's largest trading firms, will market the *Mat* in Southeast Asia. C. Itoh also has arrangements with Thiokol Chemical Corp. and Hughes Aircraft for the marketing of various products in Japan.

Mat will be deployed with both ground divisions and helicopters. Each of the programed 13 divisions of the Japanese army will have one battery of *Mat*. The battery will be equipped with 12 launchers and 124 missiles, each launcher operated by two men. The ground forces will thus have 156 launchers in field use.

H-13 Helicopters armed with *Mat* will total about 60, if current plans are carried out. This figure was slashed from about 80 helicopters in budget cuts. Officials emphasized that deployment figures are tentative, and will probably be modified by the time full adoption is accomplished.

- **Dual-purpose, aerial rocket**—Development of a dual-purpose unguided rocket is in progress, patterned after the 2.75-in. FFAR *"Mighty Mouse."* JDA has funded the project through this fiscal year.

System manager for the project is Fuji Precision Industries, which also is producing rocket motor cases. Solid propellant, being developed by Nihon Yushi Co., will be a double-base type. Two companies are working on development of a VT fuze for the yet-unnamed rocket.

Toshiba Co. and Hokushin Electric Co. have both been experiencing troubles in the development program for the fuze, but unconfirmed speculation here holds that the contract will go to Toshiba.

Expected to be in use by mid-1962, the aerial rocket will probably not completely succeed the *"Mighty Mouse"* as prime armament for JDA aircraft for some years.

Principal difference in the new JDA rocket will be in the stabilization method. The FFAR uses fins for stabilization; the JDA weapon will be spin-stabilized through use of propellant gases. Technical problems arising from this attempt at much better accuracy have caused slippage in the schedule.

Like the *Mat*, this weapon will cost more than its nearest foreign relative, but JDA feels that in both cases the additional accuracy will justify the cost. The new rocket will be used against both aerial and ground targets.

Launcher for the unguided weapon will be the F-86D and F-86F of the Japanese air force, which presently carry the *Mighty Mouse*. JDA has made the new rocket compatible with the fire control systems of both these aircraft and the missiles are interchangeable with all support equipment.

Estimated annual procurement of the new rocket may reach as high as 35,000 rounds when the new F-104J aircraft is put into service between now and 1965.

- **Replacing Sidewinder**—To equip the same three types of aircraft with a guided missile in the *Sidewinder* class, Fuji Precision Industries has been working on the *X-AAM-2*, an infrared-guided missile. In collaboration with electronics manufacturers like Nippon Electric and Toshiba, Fuji is attempting to have the weapon ready for squadron use by early 1963.

Using a solid-propellant rocket by Fuji Precision and Nihon Yushi, the *X-AAM-2* will be backed up by another missile using radar guidance, similar to the Hughes *Falcon* series. Both Doppler and pulse techniques are being evaluated on prototypes, and a choice is expected next year.

Until adoption of guided air-to-air missiles, JDA expects to use *Sidewinders*. Fourteen rounds have been delivered to Japan so far; an additional 150 rounds are expected.

A surface-to-air missile for area defense is planned. Both liquid- and solid-propellant motors are under consideration, but there are strong indications that the liquid-propellant development program will be dropped.

A liquid-propellant rocket system is being worked on at Mitsubishi Shipbuilding Co. Funds for continuation of research have been cut from the FY 1961 budget, and reinstatement is doubtful.

Mitsubishi Heavy Industries is developing the *TSAM-1*, a surface-to-air missile powered by a solid rocket from
Asahi Chemical Industries. Propell
for the solid version will be a compo
type, ammonium perchlorate with
plastic fuel and binder, including me
lic additives. Initial flights are expec
in 1962, with some acceleration ant
pated thanks to the transfer of LPR
velopment funds to the solid-propell
version.

A missile now in this class in
JDA inventory is the Contraves Oe
kon GmbH of Switzerland surface-
air missile. This liquid-propelled weap
was purchased by JDA for evaluati
Ten missiles and one launcher w
acquired.

License was granted to Mitsubi
Electric Co. for manufacture of
beam-riding missile, and the *TSAM*
will have a beam-riding guidance s
tem for test purposes until introducti
of the *Nike* system, when comma
guidance will be emphasized. This
expected to occur sometime bef
1962.

- **Only Tartar at sea**—The o
shipboard missile presently schedul
for use by the Japanese Maritime S
Defense Force is *Tartar*, an antiaircr
missile. A destroyer designed for
missile will be built within two yea
and special docks to be used in t
construction have already been start

About 42 rounds of *Tartar* missil
with associated equipment, will be
livered by the U.S. in time for t
ship's construction schedule.

Of three such destroyers under c
sideration, only the one is firm as
now. If all three are eventually bu
120 *Tartar* missiles with associat
equipment will be ordered. The 26
ton ships will be built at Nagasaki
Mitsubishi Shipbuilding Co.

A 2.25-in. sub-caliber aircr
rocket (*SCAR*) is scheduled for u
aboard the P2V aircraft. Fuji Precisi
Industries will turn out the unguid
rocket.

- **Target drones**—A design contr
has been awarded to Kawasaki Aircr
Co. by JDA for a solid-propella
powered drone with eight minutes d
ation. A dual-thrust rocket motor is u
der development for this project by D
Nihon Celluloid Co. Two prototyp
are to be built initially, then six mo
for test and evaluation.

Another project is design of a ra
jet-powered reconnaissance drone
ing a television camera. This superso
vehicle, *"B-3 Revised,"* has yet to
flight-tested. It is sponsored by JDA
counterpart of the U.S.A.F. Air R
search and Development Comman
This organization, Technical Resear
Institute (TRI), has cognizance ov
many of JDA's advanced projec
Speculation is that the ramjet is
Kawasaki product, but no confirmati
has been announced.

Blue Water Will Boast 70-mile Range

Exclusive details of major new weapon scheduled to be operational in 1963; Sweden and Germany appear interested in the top-secret system

by Bernard Poirier

THE ENGLISH Electric *Blue Water* epresents a major breakthrough in guidance state-of-art for one of our NATO allies.

The *Blue Water* has inertial guidance, mobility, solid fuel, and nuclear capabilities. Its relatively small size suggests that it could be carried on a multiple launching ramp. Its 70-mile range is only slightly less than that claimed for the U.S. *Sergeant*. Its speed is Mach 3. And it has been wrapped in one of the tightest security cloaks of any missile weapon system being developed in Europe.

–English Electric is the prime—but o one will admit making the guidance r propulsion.

–Germany is supporting its adopon by NATO—but no one will say if Germany will produce it if NATO oes not.

–The British Army has released one hotograph of the missile—or a proto-pe; and no one will admit whether is being flight-evaluated.

Woomera Range officials in Ausalia won't say they have seen it, let one admit they might be testing it. spokesman for the manufacturer isn't et allowed to say if or where it has een, or will be, tested. In answer to ueries, he replies, "I regret there is o further information available." evertheless, the *Blue Water* has all the gredients of a truly refined tactical issile.

• **Blue Water warms Swedes** — nglish Electric—through its new part organization, British Aircraft Corration—describes the missile as lighteight, only 25 ft. long, 2 ft. in diamer, with a 6-ft., 9-in. wing span and 6-ft., 5-in. fin span. It can be fired om a mobile carrier.

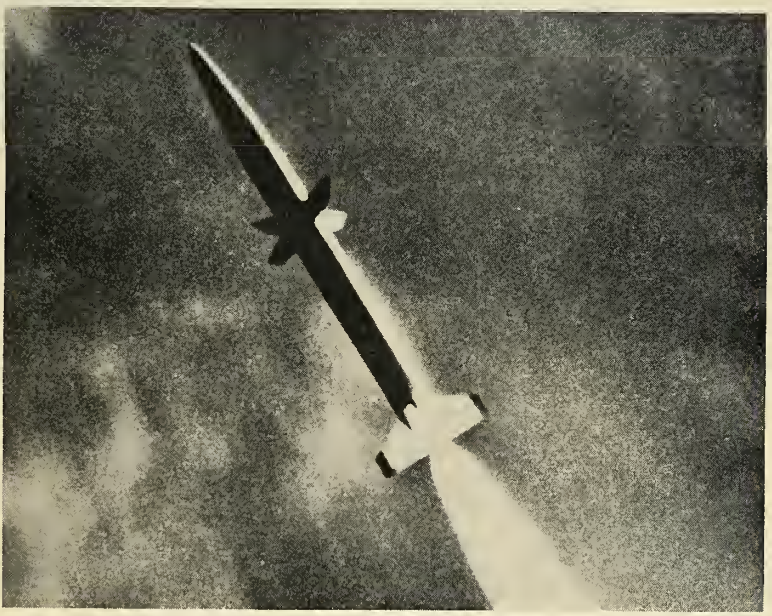
The British hope it will compete th the U.S. *Sergeant*, made by Sperry ah Engineering Lab. The *Sergeant* i operational, 36 ft. long, and has a nge of around 80 miles. It can be rried by and launched from a Frueuf transport vehicle. The U.S. Army s it deployed and it has been desibed as having both nuclear or high elosive warheads.

The *Blue Water* is in the development and evaluation stage. British officials have been promoting its adoption by various European nations since early this year. Reliable sources close to the Swedish *Armén Markrobotar* Planning Group say Sweden is seriously studying this missile, but they discount any procurement plans before "the missile becomes operational in 1963." However, there are reports that West Germany has decided to buy it.

• Apparently the price and the promise are right—and it falls into the category of tactical weapons, meaning that West Germany is free to manufacture the missile in whole or in part under the terms of the World War II peace treaty.

Under the rules of the Treaty, West Germany can manufacture tactical and defensive weapons. It cannot manufacture strategic weapons, according to current interpretation of the pact.

The British have succeeded in making further details of the *Blue Water* as elusive as the details surrounding the original disappearance of its sparkling namesake—the Blue Water gem memorialized in *Beau Geste*. ⁂



FIRST PHOTOGRAPH of Blue Water surface-to-surface missile being developed by British Aircraft Corp.'s English Electric Aviation for the British Army.

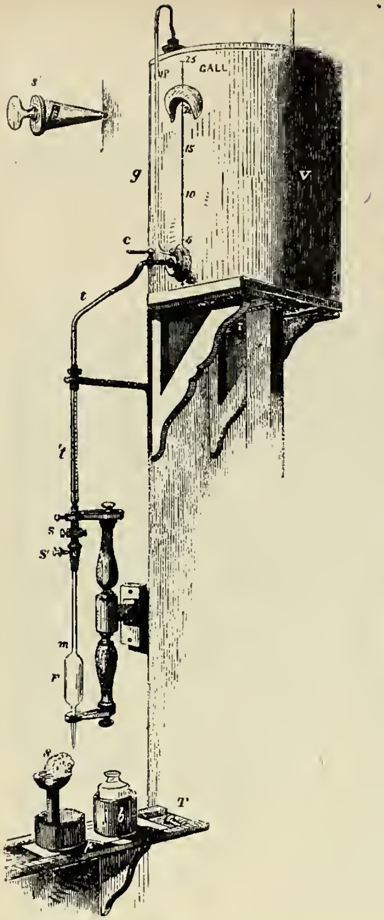
NRL Satellite

A New Dimension in Study of Solar Storms

First continuous measurements of solar activity in X-ray and ultraviolet radiation are being transmitted by the U.S. Naval Research Laboratory's *Solar Radiation I* satellite.

The satellite, orbited along with *Transit II-A* on June 22, has an expected operating lifetime of at least one year.

These solar weather reports can be correlated with ground-level observations to study behavior of the ionosphere as well as the mechanisms of solar storminess. NRL says the X-ray and ultraviolet monitoring satellite adds a new dimension to the study of solar storms, and permits monitoring the entire history of X-ray and ultraviolet emissions from start to finish. The sequence of early events in a solar flare storm is so fast that it was not possible previously to launch rockets in time to reveal the history of the flare's first few minutes.



PHYSICAL SCIENCES

Another area
of advanced inquiry at UTC

A comprehensive study of the basic phenomena in propulsion systems and their interaction with the environment is being conducted by a staff with unusual capabilities at United Technology Corporation's new multi-million-dollar research and development complex in the San Francisco Bay Area.

Specifics under investigation include:

- Steady and non-steady burning of solid composite and liquid propellants
- Detonation and explosive phenomena
- Aerothermodynamics of nozzle performance of two-phase gases involving the study of transport phenomena, adiabatic expansion laws, nucleation, phase lag, and radiation.

New concepts of major significance are evolving from this research.

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soviet affairs

By Dr. ALBERT PARRY

How do you talk to the man in the spaceship

and he to you? This is asked by V. A. Sokolov, a Russian engineer, in a long article "The Spaceship-Satellite Is Speaking" in the August issue of *Nauka i Zhizn'* (Science and Life), published in Moscow by the All-Union Society for Dissemination of Political and Scientific Knowledge. This issue has just reached the United States. The Soviet author writes: "In order to make an astronaut's flight absolutely reliable and safe, Soviet scientists and engineers have yet to solve quite a number of complex problems and to foresee thousands of details, each of which demands close attention. One such problem is the creation of dependable, high-grade, uninterrupted, two-way communication between the astronaut and the Earth."

The recent Soviet record

of successful radio- and tele-communication with the *Sputniks* and the *Luniks* is one reason why the Russians feel that "such contact with a spaceship via radio-lines can be brought about," Sokolov declares. But he points to "the many handicaps to be encountered by radio-waves between the spacecraft and the Earth." He names the ionosphere as chief of these hindrances. "In the non-ionized air the speed of the radio-waves' travel is steady; it equals approximately the speed of light," he said. "But in the ionized air radio-signals travel at a lesser speed. At that, the more frequently electrons and ions are encountered in the path of the wave, the more slowly does the wave push ahead."

The lesser speed forces the radio-wave

off its course as it moves from a non-ionized area into one that is ionized, the author explains, adding: "The radio-ray, sent from the Earth to the spaceship, may not reach its destination when it is broken by the ionosphere in such a way that it is reflected by the ionosphere as if by a mirror. The radio-ray will then be returned to Earth."

This problem can be solved by correctly choosing the length of the radio-wave which the men on Earth use to keep in touch with the astronaut. This means setting the right frequency and making the right selection of the relaying and receiving antennas. In addition, everything possible should be done "to remove the signal's distortions" which may arise in the process of sending these radio-waves.

What length should the radio-waves be?

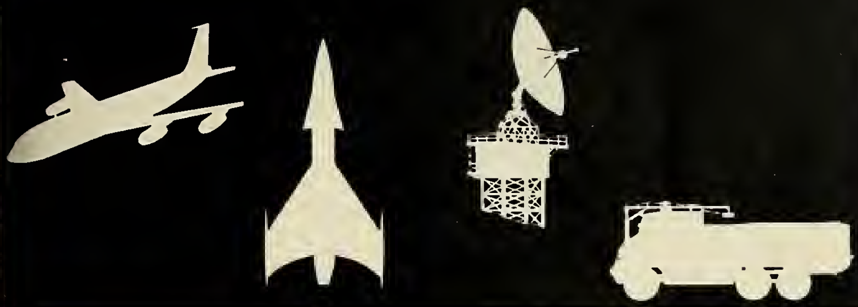
Sokolov answers: "It is clear that in distances of outer space, waves longer than 100 meters must not be used, as they simply will not penetrate the ionosphere." He strongly recommends lengths between 10 and 100 meters. He mentions the wave of 15 meters as proving the best in communications to and from *Sputniks*. Waves shorter than 10 meters can also be utilized, but in such cases either "*Sputniks* playing a relaying role should be introduced" between the spacecraft and the Earth, or the Earth should be covered with a network of receiving stations "situated in such a way as not to lose the spaceship out of the field of sight."

This last-mentioned system would work very well if all such stations are connected by radio-lines with one central point of communication. In time, man can also use the Moon as a relay communication point—by establishing an automation relay station on its surface.

To facilitate cosmic communication

the Russian engineer suggests, among other things, "a two-frequency system: one wave length from the Earth to the astronaut; the other, from the astronaut to the Earth." Clarity of voice messages at such great distances will be hard to achieve, and Sokolov lists reasons why this will be so. But he concludes that no matter how complicated each new problem, "it, too, will be successfully solved by our engineers and scientists."

WHICH PICTURE FITS YOU BEST?



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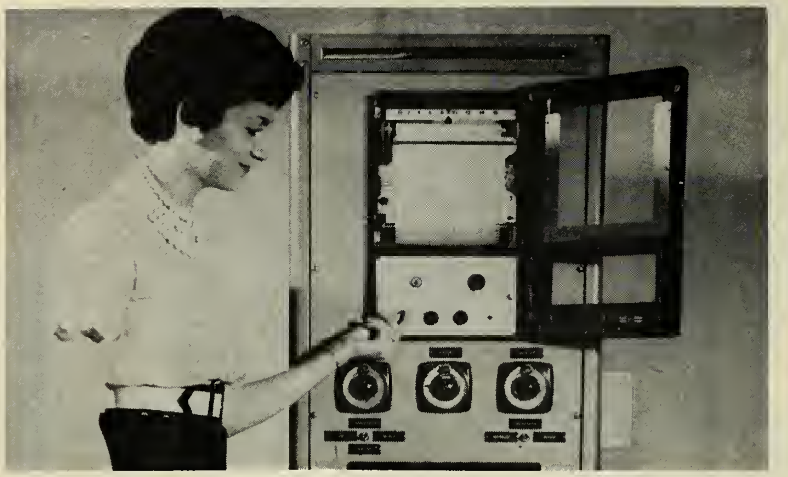


Flexible Process Control Assembly

A highly-flexible control facility, (Controlall), is being manufactured by Leeds & Northrup Co. This Assembly has been specifically designed for use in pilot plants, research laboratories and plant processes where there is need for a flexible system adaptable to practically any type of control problem.

The Controlall Assembly consists of a Speedomax H instrument, any one of three interchangeable Series 60 Control Units—C.A.T. (Current Adjusting Type), P.A.T. (Position Adjusting Type) or D.A.T. (Duration Adjusting Type), a programer and a timer and interrupters all mounted in an enclosed mobile relay rack.

The Controlall Assembly is extremely versatile in operation. It can be used as a set-point, cam program or time rate controller.

Circle No. 225 on Subscriber Service Card.

Electron Beam Shield

An 18 piece Netic Co-Netic magnetic shield which acts as a divisionary shield against magnetic effects reacting on an electron or proton beam being conveyed axially thru the center of the shield has been developed by Magnetic Shield Division, Perfection Mica Co. The Netic Co-Netic alloys are stable in vacua, therefore the entire assembly can be incorporated in a system that has to be evacuated. Removable tabulations extend beyond the perimeter and end cap to further increase shielding effect in the area of necessary access holes.

Circle No. 226 on Subscriber Service Card.

Ultra-Vacuum Ion Pump

A line of ultra high vacuum ionization pumps has been developed by Hughes Aircraft Co.

The ion pumps, manufactured in several sizes, contain no moving parts, refrigerants, traps, oils nor heating elements. One model in the new line is a compact, lightweight six-liter pump that is only one-fourth the size of conventional units with the same capacity. It pumps at the rate of six liters a second, can achieve pressures of less than 10^{-9} mm Hg in either metal or glass vacuum systems, and can be used concurrently as a vacuum gauge.

Circle No. 227 on Subscriber Service Card.

Miniature Clutch

A high-efficiency miniature magnetic clutch with a minimum torque rating of 10 oz.-in. at speeds to 1000 rpm is now available in four voltag ranges from Ultronix, Inc.

Torque loss with stainless ball bea ings is less than 0.3 oz.-in. Field sha ing and the steel-to-brass clutch fac enables the clutch to deliver up to 1 oz.-in. to the load at 2.5 watts.

Circle No. 228 on Subscriber Service Card.

Pulsation Eliminator

Pump pulsations are reduced to 1 or less of system pressure by a devic known as a "High Pressure Ripp Filter," available from Auto-Contr Laboratories, Inc. The "High Pressu Ripple Filter" is a pump pulsatio eliminator and noise trap for all class of liquid pumps.

The device has no moving part contains no elastomer or flexible sea or members, and is compatible with a liquids. The units are available in ur limited flow ranges, working pressure to 25,000 PSI, and temperatures fro −450° to 1000°F.

Circle No. 229 on Subscriber Service Card.

Flux-Coated Brazing Alloy

Flux-coated silver-brazing-type allo which will cut brazing time by tw thirds through elimination of separat flux, is available from Eutectic Wel ing Alloys Corp. EutecSil 1020F eliminates the need for flux mixin and application and reduces the nee for pre-cleaning and pre-heating.

Circle No. 230 on Subscriber Service Card.

Universal Fatigue Tester

A Tatnall-Krouse Universal Testin Machine for combination fatigue tes ing has been put on the market by th Instruments Division of The Budd C

Labelled the Model LAZ-1, the ne machine incorporates the fatigue testin principles of Dr. B. J. Lazan of th University of Minnesota. The machin provides for static or dynamic testin on a selective basis; creep or fatigu work may be accomplished with eithe of the machine's two sections: the stati unit (LAZ-1S), the dynamic un (LAZ-1D), or both.

Circle No. 231 on Subscriber Service Card.

Sonic Delay Lines

Versatile wire sonic delay lines, wit improvements in insertion loss, bandwidth, temperature stability and package size, are available to military electronics design engineers through Ger eral Electric Co.'s Heavy Militar Electronics Dept.

The Delay Lines operate on th

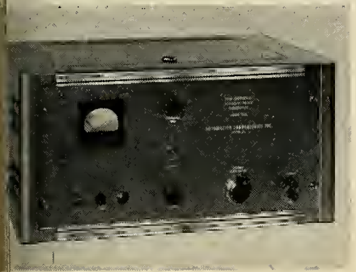
hysical principles involved in the ropagation of ultrasonic stress waves rough a special alloy wire. They can rovide long delays per unit length of ansmission line—all the way from 2 icroseconds to 20 milliseconds!

Circle No. 232 on Subscriber Service Card.

aussian Noise Generator

Automation Laboratories, Inc. is oducing a signal generator which curately produces a low frequency ussian output voltage.

The Gaussian Noise Generator has output frequency spectrum which flat to within one db from DC to cps (Model 100-A) or DC to 500 (Model 100-B). The output signal gaussian to within 1% and is 5 volts s, regulated to within 0.1 db. A tinuously adjustable attenuator is vided to decrease the output voltage m this value. Output impedance is 200 ohms.



Circle No. 233 on Subscriber Service Card.

Sund-Level Meter

A fully transistorized, battery-operad, sound-level meter weighing only 4 bs. with patented, high impedance iut, is being produced for The Korfund Co., Inc. by Dawe Instruments, Ltd., London.

Type 1400E, a self-contained acoustical instrument, features exceptional accuracy, stability, and sensitivity, giving direct readings of sound-pressure levels over the entire audio range from 24 db. to 140 db., on its 5 in. wide meter dial. Its transistors virtually eliminate microphonics.

Circle No. 234 on Subscriber Service Card.

Argon Stable Cathode

An argon-stable cathode for VacIon high-vacuum pumps has been developed by Varian Associates.

The pumping element containing the argon-stable cathode retains the simple diode construction of the standard VacIon high-vacuum pump. The same power supplies or control units are used for either version of the pump and all replacement parts are interchangeable. The new pumping element is available in the entire range of sizes of the standard VacIon high-vacuum pump including pumping speeds from one liter per second to 10,000 liters per second.

Circle No. 235 on Subscriber Service Card.

Microwave Absorbers

B. F. Goodrich Sponge Products is marketing both hair and foam type microwave absorbers backed with flexible magnetic strips, designed to simplify installation in shielded anechoic test chambers having ferrous metal walls.

This permanent plastic magnet, a BFG KOROSEAL product, eliminates the use of adhesives, brackets, etc., thereby reducing installation time and costs. The BFG Microwave Absorbers can be readily removed from a chamber for temporary use in other experiments.

Circle No. 236 on Subscriber Service Card.

Rugged Thermocouple Wire

Amperex Electronic Corp. is marketing "Thermocoax," a high temperature thermocouple wire for measuring temperatures from –200° to 1300°C. It is available in unprecedented lengths of up to 650 feet, and can be hammered, flattened and bent to extremely sharp angles with no short circuiting, loss of insulation, or rupturing of the sheath of inner conductors.

Circle No. 237 on Subscriber Service Card.

RTV/Epoxy-Si Rubber

A series of materials termed Eccosil has been introduced by Emerson & Cuming, Inc. They are room temperature vulcanizing (RTV) silicone rubbers and epoxy-silicone rubber combinations. The materials are featured by electrical excellence, particularly at elevated temperatures. As received, all are easily poured. Cures are simple. Eccosil 4640 is a silicone rubber formulation which is extremely low in weight—it is roughly 1/3 that of other commercially available materials.

Circle No. 238 on Subscriber Service Card.

Portable Thickness Gage

A complete transistorized battery-operated ultrasonic instrument for measuring wall thickness between 0.025 and 2.50 in. has been added to the broad line of test systems available from Magnaflux Corp. The portable unit, designated Sonizon SO-300, gives instantaneous reading by simply placing a transducer on the surface to be measured and turning a dial.

The unit measures with an accuracy of ±1% when calibration is checked during tests against known sample of the same material. Three knobs provide complete control of the entire test procedure.

Circle No. 239 on Subscriber Service Card.

High Frequency Meter

An ultra-high-frequency meter (Model 707, EV) produced by Electronic Ventures requires no cables, no external power supply, and no direct electrical connection to the circuit under test. With a frequency range of 400 to 800 megacycles and a sensitivity of 5 microwatts, Model 707 has an accuracy within ½ of 1%. It measures only 1½ in. diameter x 10 5/8 in. length including a built-in probe. The direct-dial read probe is designed for accessibility to confined spaces.

Circle No. 240 on Subscriber Service Card.

Silicone Insulating Tape

Continental-Diamond Fibre Corp., a Subsidiary of The Budd Co., has available a line of self-adhering unsupported silicone rubber insulating tapes.

Designated as CDF Level-Wrap tapes, they feature triangular cross sections that permit them to be readily wound on irregular shapes. Each tape is as thick at its apex as the required total insulation thickness. When wrapped in overlapping halves, the tapes give smooth, even external surfaces. A colored center line guides the wrapping and overlapping.

Circle No. 241 on Subscriber Service Card.

Cryogenic Dynamic Seal

A Cryogenic dynamic seal for use in O ring grooves with no leakage at temperatures from –423°F to 400°F in contact with liquid hydrogen, nitrogen or oxygen is available from Balsells Engineering Co. The extreme flexibility of the seal makes assembly into an O ring possible. The seal consists of a seal ring made of teflon and a spring made of stainless steel which is oval in cross section and is wound at a slanted angle to provide the load required for good sealing.

Circle No. 242 on Subscriber Service Card.

Amplitude Analyzer

Automation Laboratories, Inc. is now producing an Amplitude Distribution Analyzer which provides a direct reading of the amplitude probability distribution of the complex or random signals that occur in the design and test of false alarm and threshold circuits and in radar and infrared systems.

The analyzer, Model 200, measures the percentage of time that the signal to be analyzed exceeds a known threshold. The reading is indicated by a meter calibrated in percentage. The threshold, which is calibrated internally with a known signal, is accurately adjusted by a helipot. The amplitude probability distribution of a signal can be determined to one percent.

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new literature

SCHLIEREN PHOTOGRAPHY TECHNIQUE—A publication, which describes and illustrates the schlieren photographic technique for the study of the flow of gases, is now available from Eastman Kodak Co. The 20-page publication covers optical details of schlieren equipment, arrangement of components, accessory equipment, adjustment of the schlieren system, and photographic materials required. It is illustrated with diagrams of various schlieren methods, includes formulas to determine optical relationships, and provides examples of schlieren photographers.

Circle No. 200 on Subscriber Service Card.

MAGNETS—A permanent loose-leaf catalog listing stock permanent magnets manufactured by General Magnetic Corp. is available. The catalog incorporates all characteristics of new designs in multiple casts, blocks, bars, cylinders (solid and hollow) salient pole (internal and external radii), curved path and Genox® (ceramics) permanent magnets.

Circle No. 201 on Subscriber Service Card.

SPACE AGE METALS—A brochure published by the Lunex Co. describes and definies the properties of 16 high-purity, rare earth metals, most of which are available and are being used in the development of highly specialized products and metals. The application of high-purity rare earth metals as scavengers and alloying agents has improved mechanical and physical properties of both ferrous and non-ferrous materials.

Circle No. 202 on Subscriber Service Card.

HIGH-PRECISION COMPONENTS—Kearfott Division of General Precision, Inc. has published two rev
technical texts on the construct
performance, application, and tes
of high-precision components. (
"Technical Information for the
gineer—Servo Motors, Motor Gen
tors, Synchros," describes in detail
important technical aspects of s
components and their use in syste
The second text, "Technical Infor
tion for the Engineer—Gyros,"
cusses theoretical considerations
gyroscopic instruments and details
performance, application, construct
and testing of such instruments as
gyros, rate integrating gyros,
switches, free gyros, vertical gy
directional gyros, stable platforms,
accelerometers.

Circle No. 203 on Subscriber Service Car

SPECTROGRAPHIC CONTRO
Lebanon Steel Foundry has publis
a technical bulletin on spectrogra
metallurgical control and its appl
tion to high-alloy steel castings.
bulletin discusses the advantages
spectrographic analysis as compa
with conventional "wet" chemical
alysis, and outlines the benefits to
steel castings user through increa
accuracy of analyses, production sp
and uniform control and dependabi
of the end product.

Circle No. 204 on Subscriber Service Card

AEROSPACE FUSION WELDIN
Sciaky Bros., Inc. has published a
port of developments in highly prec
fully automatic fusion welding eq
ment. Featured within this 27-p
report are actual applications wh
Automatic Fusion Welding equipm
has been in use for the past two y
in North American Aviation's B
Program, Raytheon's *Hawk* processi
as well as others. Equipment desc
tions are also contained.

Circle No. 205 on Subscriber Service Card

AEROSPACE FASTENERS—Ra
identification of more than 160 sta
ard aerospace fasteners, by config
tion, specification number and gen
name, is provided in a 10-page re
ence listing published by Stand
Pressed Steel Co., Aircraft & Mis
Div. The brochure consists of an ei
page directory of 133 National Airc
Standard (NAS), Air Force-Navy A
nautical (AN) and Military Stand
(MS) fasteners and related parts.

Circle No. 206 on Subscriber Service Card

EDGEGRAPHING—A new techni
for hand analysis of complex engin
ing data in 10, 20, or more variab
is included in 16 pages of techn
literature available from Statist
Engineering Institute.

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names in the news

KRASNOW

POYDA

FRAILEY

MANNIELLO

MERL

John Manniello: Appointed to the new ition of director of marketing for CBS oratories, a division of Columbia adcasting System, Inc. Was formerly nager of systems sales for Fairchild nera and Instrument Corp.'s Defense ducts Div., and prior to that manager Fairchild's Washington, D.C., office.

Charles S. Ames Jr.: Former chief ject engineer and veteran member of *Atlas* missile team, named program ector-*Atlas* at Convair a division of neral Dynamics Corp.

Dr. Henry L. Richter, Jr.: Joins Elec- Optical Systems, Inc., as manager of company's newly formed Advanced ctronics and Information Systems Di- on. Was previously chief of the Space truments Section of the Space Sciences ision of Cal Tech's Jet Propulsion oratory.

Anthony Solazzo and **Allen Sheets:** earch chemist and metallurgist, respec- ily, join the staff of National Beryllia p.'s Research and Development Div. zzo comes from the research division Curtiss-Wright Corp. where he did on ceramic and nuclear reactor fuel lems. Sheets was formerly with Pratt Whitney Aircraft Corp.'s Material elopment Laboratory.

Kurt Merl: Joins United Aircraft p.'s Norden division as supervisor- ital navigation computers, responsible analysis, design and development of anced methods for navigational sys- s using digital techniques. Was for- ly head of the engineering department airborne equipment at Sperry Rand p.'s Ford Instrument Co.

Edward P. La Kaff: Appointed chief neer for Borg-Warner Corp.'s EM- R Ingersoll Products Div. Was for- ly design engineer for the Roy C. rsoll Research Center.

Harry L. Hildebrand: Promoted to ager of Process and Design Engineer- at Taylor Fibre Co. **John G. Mussel-** **, Jr.,** former general machining fore- at SKF Industries, succeeds Hilde- d as manager of the Fabricating Di- on.

Lt. Col. Richard R. Prewitt (USA-ret.): Former Deputy to the Logistical Service Div., Army Reserve and R.O.T.C. Affairs, at the Pentagon joins C-E-I-R, Inc. as assistant to the president, **Herbert W. Robinson.**

Richard W. Benfer: Director of Bell Telephone Laboratories' White Sands installation since 1953, promoted to department head and named director of the recently established Kwajalein Island Field Station, responsible for the *Nike-Zeus* test program there. **Louis H. Kellogg,** Missile Systems Development engineer, succeeds Benfer at White Sands.

Richard A. Poyda: Appointed vice president of marketing and sales for Faradyne Electronics Corp. directing functions of the Semiconductor, Capacitor and Page-Madden Divisions, as well as the seven affiliate companies which comprise the corporation.

Walter I. Shevell: Group manager of the Gyro and Servo Component Divisions of Giannini Controls Corp., elected vice president.

Neville W. James: Former member of the Atlantic Refining Co.'s research and development staff, joins International Resistance Co. as reliability-quality control engineer.

Dr. Marvin E. Krasnow: Appointed manager of the newly created technical products division of The Hallicrafters Co. Was previously manager of the chemistry and physics laboratory at Inland Testing Laboratories, a division of Cook Electric Co.

George M. Bunker, Clarence W. Miles and **Maxwell B. Bassett:** Three executives of The Martin Co., elected to membership on the board of directors of the Nuclear Corporation of America.

Jack H. Frailey: Elected director of the Programs Division of the Information Technology Laboratories, a division of Itek Corp. Was formerly manager of missiles systems in the Missile Electronics and Control Div. of RCA. Also served as project director of the *X-7A* ramjet test vehicle and *Polaris* missile programs at Lockheed Aircraft Corp.

Victor P. Kovacik: Formerly Research Requirements manager for the Tapco Group of Thompson Ramo Wooldridge Inc., moves into Tapco's New Devices Laboratories to direct preliminary design activities.

Roy E. Godfrey: Appointed deputy director of the Systems Analysis and Reliability Div. of the NASA George C. Marshall Space Flight Center. Was formerly deputy chief of the division's mechanical branch.

Stanley C. Farrow: Appointed resident engineer in the Huntsville, Ala., area for Emerson Radio & Phonograph Corp.'s Government Electronics Div. Was chief of the Mechanical Test Facilities Section, Industrial Operations, Engineering Div., Army Rocket and Guided Missile Agency.

Donald A. Forbes: Joins Corning Glass Works as chief development engineer in the Ceramic Dept. of the Electrical Products Div. Was formerly vice president and director of research at Hamilton Porcelains, Ltd.

Harry A. Pearl: Named supervising engineer of the materials laboratory at Republic Aviation Corp.'s new Research and Development Center. Was previously chief materials engineer for Bell Aircraft's Engineering and Research Laboratories.

Dr. Gerald E. Pokorny: Joins the staff of Litton Industries' Electron Tube Div., as a senior scientist in the division's research laboratory.

Dr. Martin J. Swetnick: Joins NASA as director of instrumentation of the lunar and planetary exploration programs. Was formerly chief physical scientist for the Defense Atomic Support Agency's Radiation Division.

Ralph A. Escribano: Former senior electronics engineer for Ets-Hokin & Galvan Inc., appointed manager of engineering sales and advertising for Delta Design Engineers, Inc.

Frank G. Marble: Former vice president and general manager of Boonton Radio Corp., a Hewlett Packard subsidiary, joins Systron-Donner Corp. as assistant to the president.

contracts

NASA

The Budd Co., Philadelphia, for development, design and fabrication of the stainless steel structure of the *S-6* atmospheric satellite. Amount not disclosed.

$23,000,000—Grumman Aircraft Engineering Corp., Bethpage, L.I., N.Y., for development of an eight-sided satellite, 9½ ft. high and 6½ ft. in diameter, weighing 3200 lbs. (Being negotiated).

NAVY

Ford Motor Co's Aeronutronic Div., for comprehensive study of potential hazards involved in launching missiles. Amount not disclosed.

Laboratory for Electronics, Inc., Boston, for continued "research in ferromagnetics with applications to new storage devices."

$41,303,720—General Dynamics Corp.'s Convair Div., for production of *Tartar* supersonic surface-to-air missiles. Will be produced at the Naval Weapons Industrial Reserve Plant, Pomona, Calif.

$3,500,000—Aircraft Armaments, Inc., Cockeysville, Md., for development, manufacture and installation of an antisubmarine warfare training facility at Pearl Harbor.

$250,000-plus—Pickard & Burns, Inc., Needham, Mass., for evaluation of equipment performance of the Navy communications center now nearing completion on the edge of Machias Bay.

$100,000—George Rattray & Co., Inc., Hicksville, N.Y., for precision potentiometers.

ARMY

$4,277,000—Bulova Research & Development Laboratories, Woodside, N.Y., for further work on the warhead section of the new "shoot-and-scoot" *Pershing*. Subcontract from The Martin Co.

$855,963—IGG Kellogg, div. of IT&T Co., Chicago, for *Atlas* and *Titan I* blast detection systems.

$850,000—Packard Bell Electronics Corp., Los Angeles, for production of various electronic subsystems of a radio relay communications system used by field armies.

$68,632—Raytheon Co., Waltham, Mass., for concurrent repair parts for the *Hawk* system.

$67,397—C. A. Meyer, Orlando, Fla. for construction of *TM 76A* RFM launch pad trench complex.

AIR FORCE

Hamilton Standard Div., United Aircraft Corp., Windsor Locks, Conn., for ground air conditioning carts for *Titan I*. Subcontract from The Martin Co. Amount not disclosed.

Elliott Engineering Co. Inc., Lynwood, Calif., for development of aluminum bellows for the *Titan*. Subcontract from The Martin Co.-Denver. Amount not disclosed.

$2,352,788—Air Products, Inc., Allentown, Pa., for propellant oxygen and/or nitrogen. (Two contracts).

$1,000,000—Space Electronics Corp., Glendale, Calif., for development of electronic and electrical systems for the *Ablestar* second-stage booster to be used for future launchings of *Transit* and *Courier* satellites. Subcontract from Aerojet-General Corp.

$940,000—General Electric Power Tube Dept., Schenectady, for building 40 high-power, long-life klystrons for the FPS-7 radar system.

$421,180—John E. Fast & Co., Chicago, for development and manufacture of capacitors to be used in the inertial guidance and control systems of the *Minuteman*.

$155,362—Convair Div., General Dynamics Corp., San Diego, for spare parts applicable to airborne rocket launchers.

$100,000—Avien Inc., Antenna Dept., Woodside, N.Y., for construction of a radical new type of modular antenna system for use in the first unmanned automatic missile and satellite tracking station to be built by the AF.

MISCELLANEOUS

Space Technology Div. of Guardite Co., Wheeling, Ill., for designing and building a new hyper-environmental space simulation test chamber for Lockheed Aircraft Corp.

$428,000—Dynamic Developments, Bethpage, N.Y., for design and development of a set of high speed, super-cavitating, submerged hydrofoils. Awarded by U.S. Maritime Administration.

reviews

RESEARCH IN RADIATION DAMAGE IN SEMICONDUCTORS, J. W. Harrity and others. Order PB 161673 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. 157 pp., $3.

A diode resistant to nuclear radiation damage was constructed in this research program as the result of extensive studies of nuclear irradiation effects on semiconducting materials.

The diode uses p-type germanium with resistivity of about 0.20 ohm-cm as the base material. Principal object of the study was to determine the mechanisms by which radiation degrades semiconductor devices.

The researchers state that one of the most significant accomplishments of the program was the development of the instrumentation and techniques of measurement used with the General Atomic electron linear accelerator. Results acquired by their experiments demonstrate that performing detailed measurements while the sample is being irradiated can be accomplished with minimum use of expensive accelerator and reactor time.

BASIC CARRIER TELEPHONY, David Talley, John Rider, Inc., New York, 176 pp., $4.25.

This book's early chapters cover telephone carrier definitions and carrier system fundamentals—speech characteristics, the phenomena of modulations, demodulations and sidebands, and the different types of filter networks used in carrier telephony.

Having established telephone definitions and notations, the author goes into carrier telephony circuitry, discussing special types of modulators, carrier controls, and switching. Final chapters c with carrier system operations, describ the operation of the carrier channel a voice channel in four-wire carrier te inals and two-wire carrier channel ope tions.

SPACE BIOLOGY: THE HUMAN FACTC IN SPACE FLIGHT, James S. Hanrahan David Bushnell, Basic Books, Inc., New Y 263 pp. $6.

The authors present a very thoro discussion of the biological problems c fronting the space traveler, including history of the experiments contributing present knowledge. Drs. Hanrahan a Bushnell are scholar-historians at Hol man Air Force Base in New Mexico, of the principal centers of research in t field, but the work is written in non-te nical, narrative form.

HANDBOOK OF CHEMISTRY AND PH ICS, forty-second edition. The Chemical R ber Company, Cleveland, Ohio. 3400 pp. $

This continually revised book is the only one-source reference in the wo covering Mathematics, Physics and Che istry in a single volume.

Over 200 experts have contributed the edition, which includes new tables Diffusion of Metals into Metals, Int planetary Orbits, and Standard Types Stainless Steel, among many other subjec

CERMETS, Edited by J. R. Tinklepaugh a W. B. Crandall, Reinhold Publishing Cor New York, 239 pp., $9.50.

The editors have followed the maj areas of emphasis in cermets in the Unit States with the idea that the detailed i formation pertaining to titanium carbi and aluminum carbide might be applied other cermets.

No effort has been made to include tl European effort in this field. The physic chemical aspects of cermets are well co ered. Through this the reader may becon acquainted with the relationships betwe ceramics and metals which govern tl selection of materials and the properti obtained. Surface energy as related cermet theory is traced in considerab detail.

SYNTHESIS OF NEW HIGH TEMPERATU MATERIALS, J. L. Engelke and others. (ord PB 161720 from Office of Technical Service U.S. Department of Commerce, Washingt 25, D.C.) 44 pp., $1.25.

This research project was set up t study a number of mixed-transition met carbides, borides, and nitrides as a bas for development of materials able to wit stand severe operating conditions at ultr high temperatures.

An implosive-shock technique valuabl for the synthesis of compounds which r quire high pressure to prevent thermal d composition of metal was developed.

The report points out that much ne knowledge is required in the field of hig temperature chemistry. For example, a adequate theory of bonding is needed i order to predict new stable compounds.

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Joint Meeting, Institute of the Aeronautical Sciences and Canadian Aeronautical Institute, Queen Elizabeth Hotel, Montreal, Oct. 17-18.

ASME-ASLE Lubrication Conference, Statler-Hilton Hotel, Boston, Oct. 17-19.

42nd National Metal Exposition and Congress, Trade and Convention Center, Philadelphia, Oct. 17-21.

American Ceramic Society, 13th Pacific Coast Regional Meeting, Ambassador Hotel, Los Angeles, Oct. 18-21.

Annual Meeting, Society for Experimental Stress Analysis, Hotel Claremont, Berkeley, Calif., Oct. 19-21.

Symposium on Space Navigation, Institute of Radio Engineers, Deshler-Hilton Hotel, Columbus, Ohio, Oct. 19-21.

Conference on Hypervelocity Projection Techniques, University of Denver, Institute of the Aeronautical Sciences, Denver, Oct. 20-21.

ASME-American Society of Mining, Metallurgical and Petroleum Engineers, Fuels Conference, Daniel Boone Hotel, Charleston, W.Va., Oct. 24-25.

Medical and Biological Aspects of the Energies of Space Symposium, sponsored by USAF Aerospace Medical Center, (ATC) Granada Hotel, San-Antonio, Tex., Oct 24-26.

Seventh Annual East Coast Conference on Aeronautical and Navigational Electronics, Lord Baltimore Hotel, Baltimore, Oct. 24-26.

Government Contracting Course, National Defense Education Institute, sponsored by NSIA and Harbridge House, Inc., Detroit, Oct. 24-Nov. 4.

11th National Conference on Standards, Sheraton-Atlantic Hotel, New York City, Oct. 25-27.

1960 Computer Applications Symposium sponsored by Armour Research Foundation, Morrison Hotel, Chicago, Oct. 26-27.

IRE Professional Group on Electron Devices Meeting, Shoreham Hotel, Washington, D.C., Oct. 27-28.

IRE, 13th Annual Conference on Electrical Techniques in Medicine and Biology, Sheraton-Park Hotel, Washington, D.C., Oct. 31-Nov. 2.

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editorial . . .

Get the Issue into the Open

THE PROBLEMS OF the United States lie uneasily all over the world today.

They are the problems of the new African states, of civil war in Indonesia, of Laos and Algeria, the strangulation of Berlin and the slavery of the Soviet Satellites.

They are punctuated by the hand-hammering of Khrushchev as he tries to control the United Nations or destroy it, as he threatens unilateral action of Russian military forces.

They are problems of diplomacy but they are more than that. They are problems of prestige and strength.

Military strength has been called the extension of diplomacy. Prestige, then, is the morale of diplomacy—confidence or lack of it.

The state of our military strength and the state of our world prestige are the two overriding factors in the struggle this nation is involved in today—the cold war against Communism.

Our international prestige is lower today than at any time in memory. Our military strength is at best a question mark when compared with that which might be hurled against us.

Prestige today depends on many things; one of the greatest of these—perhaps the greatest—is supremacy in the race for space. Defense is strength in being. The two of these are inextricably linked, a fact which is well understood, particularly by the leaders of the Russian military.

Two weeks ago we at MISSILES AND ROCKETS wrote an open letter to the two presidential candidates. We proposed a nine-point program which we offered as a starting point from which our defense/space program could progress to leadership.

We said that the defense/space issue was one of the most important of the campaign and that it had not been discussed; that the public did not clearly understand the issue. We urged the candidates to bring it out into the open.

Senator Kennedy replied to our letter, a reply which was carried in last week's issue. Vice President Nixon has promised a reply which we hope to carry in our magazine of Oct 24.

FROM THE LETTERS we have received (Page 13) it is obvious there is a tremendous interest in the state of our defenses and in the race for space. The public is concerned.

The letter from Senator Kennedy made his stand known to the voters. We hope and expect that Vice President Nixon's will do the same.

This is an excellent start. We are proud that we have started the movement to bring the defense/space issue out into the open—but this is not enough.

Each candidate should and must devote a major speech to the subject so that it can be reported by the nation's great mass media. He should recognize that our position in the world and perhaps our survival is at stake. He should spell out his views in full detail. All of the voters have a right to know.

Clarke Newlon

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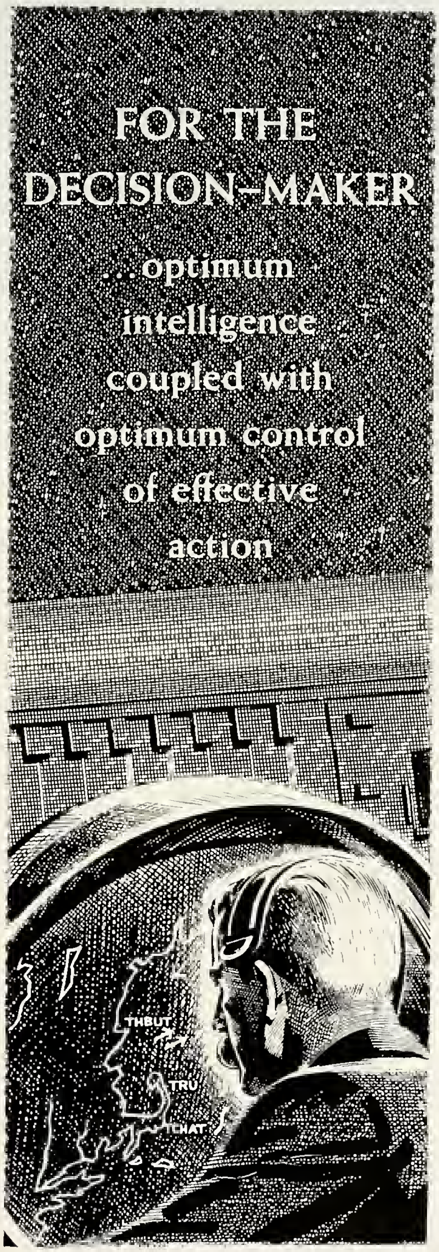
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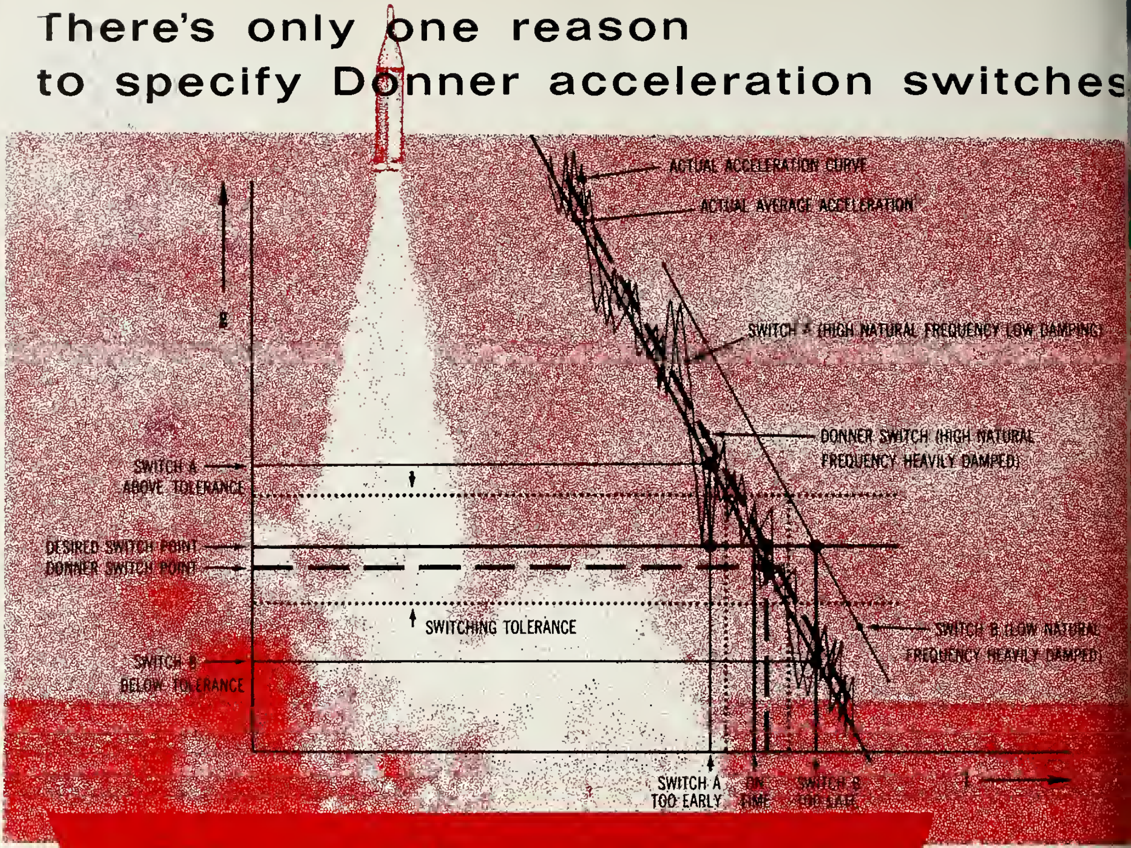

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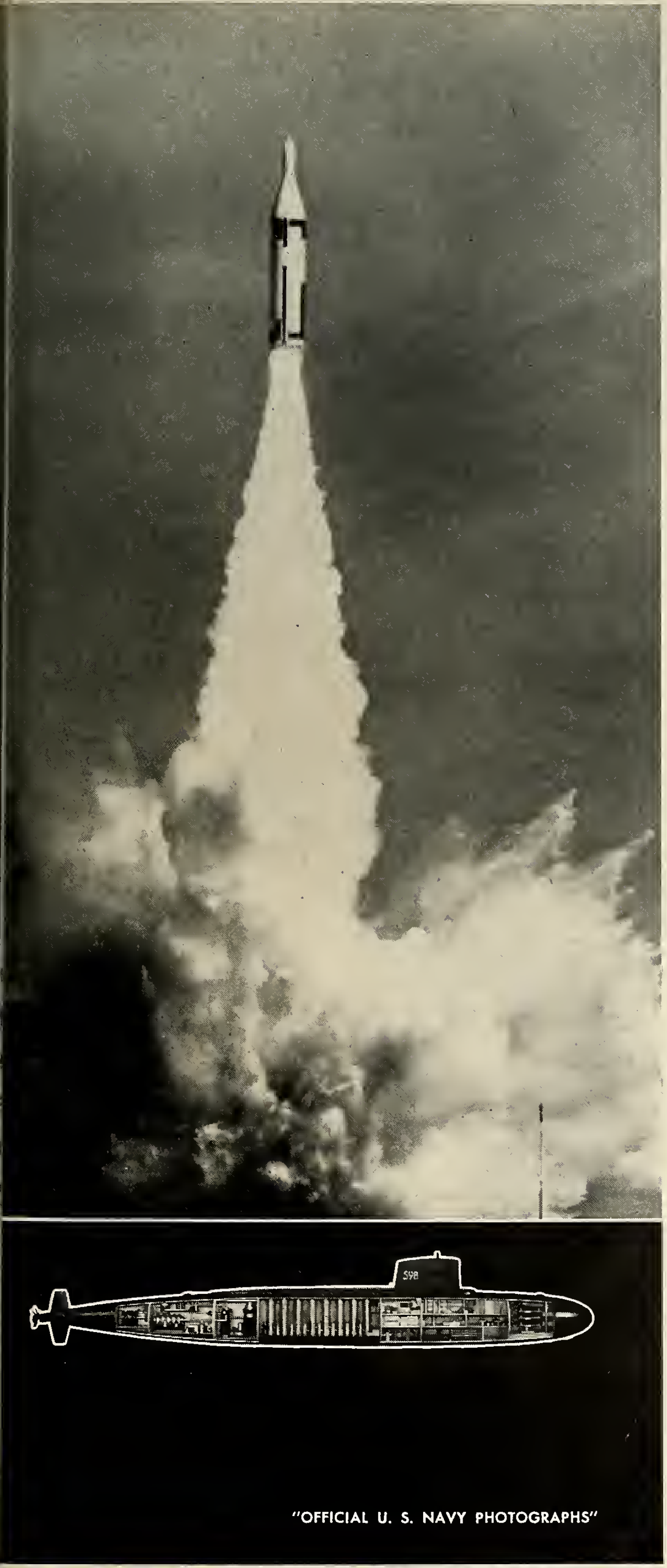
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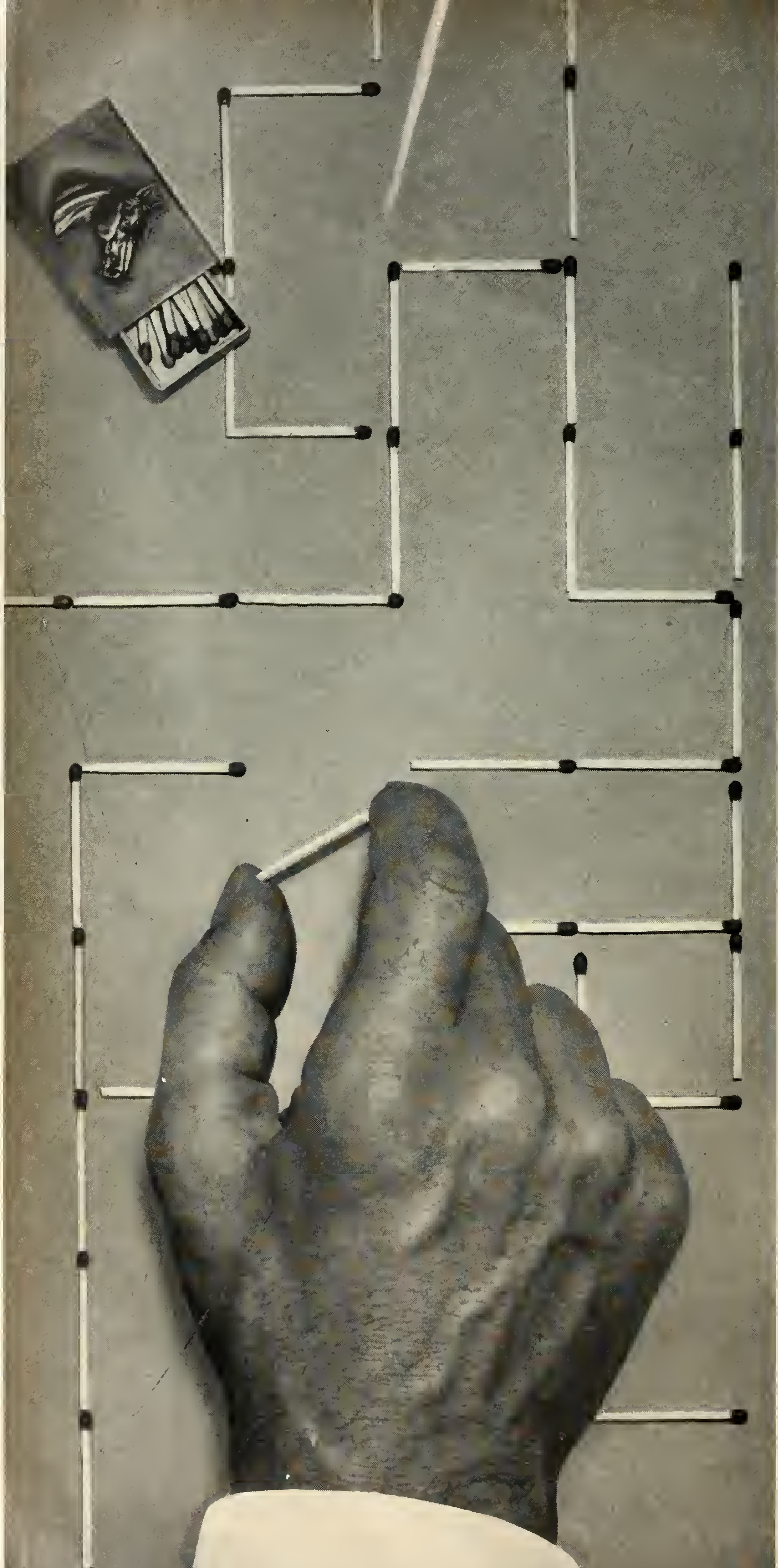

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THE COVER

Heart of the new remote control system for surveillance drones, developed for the Army by Ford Instrument and successfully tested. See story on p. 40.

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the Editor:

My friend, Dr. John Pierce, will be e first to deny your statement in the ugust 22nd issue that he originated the ea of communications satellites in 1955. the best of my knowledge this con-ption was first put forward by myself the October 1945 issue of the British urnal *Wireless World* in an article under e title “Extra-terrestrial Relays.” In this ticle I pointed out that satellites might ovide the only practical solution for orld-wide communications and in partic-ar I stressed the importance of the tationary” or 24-hour satellite. The con-ption reached a wider public in my oks *Interplanetary Flight* (1950) and *e Exploration of Space* (1951) and was irly common in the literature of Astro-utics during the early 1950's. I believe at John Pierce and his colleagues were e first to suggest the use of passive bal-on type communications satellites such the recently launched *Echo* and cer-inly they deserve most of the credit for tting this conception realized in practice.

Discussions over priority are usually dious and unprofitable, but I feel rather rongly on this point as so far my total ancial reward for the conception is 50 llars—the fee for the original article. f course, it may yet turn out that Oberth Tsiolkovsky thought of the idea first, ough this seems a little unlikely as the hole art of communications was in such primitive state when they proposed their iginal ideas on spaceflight.

Arthur C. Clarke
Clarke-Wilson Associates
Colombo, Ceylon

ptics Slip-ups

o the Editor:

I assume that either Dr. K. Pestrecov Mr. Glenn Wooters of Nortronics have ritten regarding the errors in your article escribing the “60” mm Ballistic Camera. s the author of the specification under hich Nortronics is designing the camera was surprised that the two important oints were muffed, i.e., it will have a re-active lens of 600 mm with an aperture tio of f/2. The large aperture particu-rly is felt to be quite an advance in de-gn considering the relatively long focal ngth.

Another error cropped up concerning nother specification I wrote while at atrick AFB, and that is for the SORTI tar Oriented Real Time Instrument). adiation Company is at present working nly on a study contract to investigate e feasibility, and if feasible, to offer de-gn approaches to fabrication. No hard-are is involved in the present contract, nd it is unlikely that any procurement ill result in the immediate future. There also a strong argument against an in-rument of the nature of SORTI being lassed as a camera or even in optical strumentation, since the stipulation of real time puts this in the same areas as infra-red, neither beast nor foul.

In spite of the various errors, however, I think all of us in optical instrumentation got quite a lift out of the feature article in M/R. As was pointed out the budget for optics has increased steadily the last few years, as it has become more evident that electronic instrumentation, while making even faster strides than optics, can not carry the entire load.

Carleton C. Emery
Project Engineer
RCA Service Company
Camden, N.J.

Black Brant Roles

To the Editor:

The brief mentions of the Canadian *Black Brant* rockets on pages 23 and 25 of your 3 Oct 60 issue contain several mistakes which should be corrected, particularly in connection with industrial participation in the program.

The Defense Research Board of Canada (DRB) has been responsible for the Canadian rocket research program at Fort Churchill up to the present time. The *Black Brant* vehicle has been used there by the Canadian Armament Research and Development Establishment (CARDE) to carry out seeding experiments intended to determine the density of atomic oxygen and nitrogen at an altitude of 100 km. The 1960 program includes use of the *Black Brant* by the DRB's Defense Research Telecommunications Establishment in studies of radio absorption effects in the auroral zone. Both DRB and the National Research Council of Canada plan instrumentation of *Black Brant* vehicles for 1961.

The development of the Canadian rocket has been the responsibility of CARDE. Commencing with the successful development of the propulsion test vehicle known as *Black Brant I*, the program has now progressed to the design and manufacture of a vehicle called *Black Brant II*, which is scheduled for test launchings at Fort Churchill in the fall of 1960.

In the development of these vehicles CARDE has carried out all the solid propellant research and also is the exclusive manufacturer of propellant and filler of engines. Bristol Aircraft Limited of Winnipeg, Manitoba, produced the engine casings and was responsible for the configuration of *Black Brant I*. The design of *Black Brant II* has been largely the responsibility of Canadair Limited of Montreal, Quebec.

Provided that the development of *Black Brant II* is successful, it will be used exclusively for firings in the 1961 program to attain higher altitudes with larger payloads.

E. W. Greenwood
for Defence Research Member
Department of National Defence
Canadian Joint Staff
Washington, D.C.

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The Countdown

WASHINGTON

eus: Ike Says, 'No'

Within days, the Eisenhower Administration again has turned down an Army request to begin immediate production of the Western Electric *Nike-Zeus*. The decision—said to have been made by the White House—would delay any final okay for production of the A-ICBM until after the full system is testing in 1962. The result: *Zeus* then would not be deployed before the mid-60's at the earliest. Originally, it was to have been operational in late '62 or early in 1963. However, there could be another switch—after a new administration takes over in January.

eus: NORAD Says 'Yes'

The North American Defense Command is understood to be strenuously objecting to the two-year shelving of *Zeus*. NORAD is calling for a program that would protect more than 50% of the nation's urban population. Estimated cost: $8 billion.

ever Chart

Public temperature-takers in both the Nixon and Kennedy camps are still undecided whether anything is to be gained politically by debating the coming Missile Gap in Detail. Some feel the issue is so complicated that the public is bound to misinterpret it as meaning the nation is weak today—a pitfall for either candidate.

kybolt Jr. Needed?

Proposals in favor of developing an ALBM with a range of 500 miles—half that of the Douglas *Skybolt*—reportedly are being made to the Air Force. The argument for the junior version: *Skybolt* is understood to be too large to use on the B-58 Mach 2 bomber. Backers of a smaller ALBM contend further that it would be as effective when combined with the B-58 as the *Skybolt* with the slower B-52.

ore Atlas Pads at Ready

First operational bird is now at Warren AFB (Cheyenne, Wyo.) Site 2, indicating that the pads are approaching the point where they can be turned over to SAC. Site 2 will add three more combat *Atlases* to the six already in war-ready status at Warren.

igger Hydrofoils Next

COUNTDOWN hears from a top source that the Navy is considering designs for a fleet of hydrofoil warships displacing up to 500 tons. Prototypes are expected to be available for testing "in the next few years." Prime mission for these warships will be ASW and as anti-missile missile launchers.

INDUSTRY

lamping Down on Contractors

Both the Air Force and Navy are warning their contractors to cut their costs—or else. The "or else" will come from Congress. AMC Gen. S. E. Anderson says bluntly that an across-the-board procurement cut (3% in 1960) could be hiked next year to 18% by Congress "if this upward geometric progression continues."

ASW Market Boost

Look for a sustained contract fallout from the Navy's proposed AUTEC (Atlantic Underwater Test and Evaluation Center) for several years. Cost of this ASW range is estimated at $100 million (see page 15) over a 10-year period—but this is believed to be just the beginning.

Base Activators Move

ICBM site management officials—now under AMC's Ballistic Missile Center—are moving from BMD headquarters in Inglewood to Norton AFB, San Bernadino, Calif. Vacated facilities will be occupied by BMD rapidly expanding space operation.

Missile City

Big pitch for locating a 150-*Minuteman* ICBM squadron around Cheyenne, Wyo., will probably come after the election. The town's leaders—who already have embraced the location of 24 Warren AFB *Atlas* pads—are pressing for the *Minuteman*.

INTERNATIONAL

Irish Space Center

A major space research center for Western Europe is being established at Queen's University in Northern Ireland. The center is being built in cooperation with ARPA. Facilities will include a $150,000 digital computer. Total cost the first year will be about $200,000; more than $50,000 a year from then on.

Dutch Missile Strength Revealed

The Royal Netherlands Air Force is scheduled to have four Western Electric *Nike* squadrons by the end of next year. Meantime, the Dutch Army is expected to begin buying JPL Sperry *Sergeants* and Nord *S-11's*.

Argentina Sets Missile Pace

The Argentines are continuing to lead South America in many fields of missile development. Fabrica Naval de Explosivos is manufacturing solid propellant for short-range rockets. Meantime, Universidad de La Plata has picked up government research funds for work on special liquid propellants.

Victor Scrubbed for Skybolt

The British are understood to have decided to put the Douglas *Skybolt* on Avro Vulcan bombers only. The Handley Page Victors will not be used with the U.S. ALBM. The Vulcans will join B-52's in test launching *Skybolts* from Florida.

U.N. Space Effort Stalled by Soviet

United States is ready to blast Russian obstruction of the year-old Committee on Peaceful Uses of Outer Space which has yet to hold a meeting; debate could affect campaign

UNITED NATIONS—The United States is expected shortly to accuse the Soviet Union of blockading efforts to insure the "peaceful" exploration of space through the United Nations.

The charge could be injected into the disarmament discussions before the U.N.'s 99-member Political Committee or put directly before the General Assembly. As such, it could become a key side issue in the general disarmament question.

For almost a year, MISSILES AND ROCKETS was told this week, the Soviets have succeeded in preventing the U.N. Committee on the Peaceful Uses of Outer Space from being organized. The committee has no work program, no rules of procedure, and no officers.

Indeed, it has never met.

The situation is rather painful to the United States and the Eisenhower Administration—since it was the prime mover in getting the committee created on Dec. 12, 1959. While the committee was not intended to establish controls over the use of space for military vehicles, it was hoped the group would take the lead in exploiting space for the benefit of all nations—through improved weather forecasting and communications, and in the orderly conduct of space exploration.

This high-minded aim is in danger of becoming a monumental flop.

• **Fight for chair**—In the past year, during numerous preliminary talks, the Russians have insisted that they should head this potentially enormously powerful committee.

The Soviets claim they should have the chairmanship, U. S. sources say, because "they claim they are ahead of everyone in space and the big job on the committee is therefore rightfully theirs." They also are contending for other key committee jobs.

The United States has balked down the line. Handing Russia control of the committee would open the "Prestige Gap" in space still further. So the U.S. has insisted there be no change in the normal procedure for electing committee officers.

Under the structure of the committee, Russia is clearly outvoted. There are 12 Western, 5 neutral and 7 Communist bloc nations in the group.

It is understood that the Russians also are fighting for one or more chairmanships of three subcommittees. These include legal and technical subcommittees and a third to set up an "international scientific conference" to be held in 1960 or 1961.

• **Time running out**—Until now, the impasse precepitated by the Russians has been discussed only in private. Officials concerned have hoped the Soviets would eventually agree to participate—as they did, after much footdragging, in the International Atomic Energy Agency. But, as the months have worn on, they have become increasingly discouraged, so that the only recourse seemed to be to force a solution before the General Assembly.

Time is pressing. Membership of the 24 nations extends only until the end of next year. The present session of the U.N. affords the only opportunity to get the committee in operation. Already, the chances that an international scientific conference sponsored by the group will be held in 1961 appear remote.

It is doubtful in the extreme whether the committee, even if it were grappling directly with the problem now, would be able to dampen the military aspect of space in the current international climate. The United States is pushing development of the *Samos* and *Midas* satellites as warning systems against a Soviet missile attack. Both nations are working on manned orbital vehicles—the Russians reportedly far ahead of the U.S. in development of a *Dyna-Soar* type space "bomber."

Against this rush of spacebound military hardware, the U.N. is powerless. It has no police force nor any foreseeable means to regulate the of space.

Thus the dilemma of the U.N. Co mittee on Peaceful Uses of Outer Spa may seem academic. However, the are observers here who feel that floor fight—if properly managed could serve a useful purpose in focu ing world attention on a threat lo ignored by the general public, t strategic use of space to dominate t globe.

• **Campaign overtones**—There some question whether a debate ov the blockading of COPUOS would ta this tack because it is part of the d armament issue. Domestic political co siderations of the Eisenhower Admin tration also may be a factor.

Rightly or wrongly, many peop have looked to the committee as means of regulating the military us of space; a first step, perhaps, towa carrying out President Eisenhower suggestion at the beginning of this U.N session that space be made "off limit to military vehicles.

To have the committee fail in showdown with Russia would be setback to the West, and conceivab could have repercussions in the closin weeks of the U.S. presidential cam paign. For Vice President Nixon ha so far avoided debate over the sta of the nation's defenses or the strateg implications of space.

Senator Kennedy, on the othe hand, has stated (M/R, Oct. 10, p. 1 that the U.S. is in a strategic spac race with Russia "and we have bee losing." He said further in respons to an open letter from MISSILES AN ROCKETS that "freedom of space mu be assured, preferably by mandate o the United Nations."

If the question of the future of th Committee on Peaceful Uses of Oute Space is argued in the U.N. on thes terms, the issue could set the cam paign on fire. The next few days coul decide whether it will.

as election nears . . .

Nixon 'Declines' to Join Defense/Space Debate

WITH LITTLE MORE than two veeks to go in his campaign for the residency of the United States, ichard M. Nixon has thus far refused o take a definitive stand on the issue f defense and space.

In a brief and almost off-hand refrence to defense before the American egion convention in Miami on Oct. 8, he mentioned "survival of the ation" and said, according to United ress International:

"This is not the time to discuss hese problems from a political standoint. This I decline to do."

There is no obtainable record that e has said anything at all on space xploration or its part in national efense.

In an open letter to both candidates n Sept. 27, the editors of MISSILES ND ROCKETS asked each to make nown publicly his stand on the deense/space issue. The letter contained nine-point proposal (see box, page 4) advanced as a working basis during e next four years for achievement f parity or better with Russians in ational defense and the race for space.

The open letter was published in ct. 3 M/R. Senator Kennedy's prompt eply was published in this magazine e following week, Oct. 10.

Both the Nixon-Lodge headquarters n Washington and Herbert Klein, the ice President's press adviser with the ixon party, have informed MISSILES ND ROCKETS almost daily that Nixon as personally studying a reply to the pen letter but was holding it up beause he expected to make one and erhaps more speeches on the deense/space issue.

Letters to M/R published this week nd in previous editions strongly indiate that the public is interested in this sue and wants to see it brought into e open in any form—major speech r reply to the open letter.

Nixon's "This I decline to do" statement before the Legionnaires makes it seem unlikely that he intends any public discussion.

It also makes it seem unlikely that he will reply to the M/R letter.

The attitudes of the two candidates on the defense/space issue are presented herewith as outlines in their public utterances during the campaign. Kennedy gave his in reply to the open letter, and has repeated them frequently since.

KENNEDY

–We are in a strategic space race with Russia and we are losing.

–Control of space will be decided in the next decade, and the nation which controls space can control the earth.

–This is the new age of space exploration. We must expedite accomplishment of a space platform, placing an American on the moon, nuclear power for space exploration, a combined aero-spacecraft.

–Freedom of space must be assured, preferably by the United Nations. The U.S. must have pre-eminence in security as an umbrella under which we can explore and develop space.

–The Defense Department must be reorganized.

–We should study the feasibility of reorganizing the military services according to functions and missions.

–He would request a supplementary budget appropriation in January to accelerate *Polaris* and *Minuteman* programs, expand U.S. conventional forces, provide immediate reaction to nuclear attack, harden and disperse aircraft and missile bases, speed up submarine defenses, develop space warning and anti-missile systems.

–Defense spending must be based on security and not on predetermined budget ceilings.

–We must establish and promote national scientific goals.

–He would issue a mandate to speed the decision-making process for defense/space projects.

NIXON

(In the Nixon-Rockefeller agreement before nomination).

–Create a nuclear retaliatory power capable of surviving a surprise attack to inflict devastating punishment on any aggressor.

–Possess a powerful second-strike capability, a modern flexible and balanced military establishment.

–Provide more and improved bombers, airborne alert, speeded production of missiles and *Polaris* submarines, accelerated dispersal and hardening of bases, modernization of equipment, an intensified program for civil defense.

(In Detroit on Aug. 24)

–"Today we can say categorically and we can say proudly that the United States is first in the world militarily."

"We must always take advantage of the new technological developments, we must not be frozen into acquiring and depending upon the weapons of the past to fight the wars of the future.

(In Beverly Hills on Oct. 14)

–He would establish a committee in the Department of Defense of all secretaries and chiefs of staff to re-evaluate defense policies.

Although Nixon seemed disinclined to make known cleary and unequivocally his stand on the defense/space issue, it seemed to some observers that his advocacy of more and more committees was a partial reply to Point Nine of the M/R proposal.

This was to restore decision-making to defense and space organizations—where industry has long complained that decisions are all too often passed fruitlessly from committee to committee.

Horner Calls for Diversified Effort

Broad Program Needed

To the Editor:

As regards the substance of your proposal, I think I should say that generally I am in agreement with the principles set forth but feel obligated to take exception with some of the details. There can be no question that the fact and character of Russian space accomplishments have had, and should continue to have, a bearing on our space activities. In the world of today, we could ill afford to ignore the accomplishments of a people that live by an ideology so foreign to our own. This is especially true in an area of effort so visible as that of space exploration.

I have long felt that the real long-term gains for the United States in the space exploration program will accrue because it is so effective in supporting and advancing out technology. We should, therefore, not compromise the quality of these gains by limiting our activity to only those specific areas in which the U.S.S.R. seems to be active at the moment. Rather, it is important that a broad, diversified program be undertaken which will optimize all of the returns and at the same time be comprehensive and energetic enough to assure a liberal share of recognizable firsts for prestige purposes. I am convinced that these two objectives need not be in conflict and are reasonably available within the resources that the nation can and should afford.

I believe some of your specific proposals for space accomplishment are subject to question. The difficulty lies with the relative priority which seems to be established by the proposed time of accomplishment. For example, the proposed "U.S. citizen on the moon" in the 1967-68 time period may very well be imposible at any price. I am certain that, under the best of circumstances, the cost would be so high as to raise the question as to whether the expenditure rate was justified by the end result.

This would be especially true if it necessitated the dislocation of the defense program or the rest of the space effort in order to make the necessary allocation of resources—people and facilities as well as money. There is no question that it can be accomplished at some point in time, but I am sure you would agree that we should not arbitrarily throw our total effort off balance without very careful consideration.

In response to the third of your itemized proposals, I must state that I believe there is a great deal of confusion surrounding the phrase "freedom of space." If it revolves around the question of jurisdictional authority over vehicles in low orbit as they pass over national boundaries, then I suspect that this might some day become a debatable issue on the geopolitical front and specifically as regards the boundaries of free space.

It is interesting to note that one does not usually hear the term "freedom of the seas" in reference to relative undersea forces. I can't help but feel that this stems partly from the frustration of the problem of denying undersea space to any National entity. At least we seldom voice concern that we might be denied the use of this space in projecting our national interests, although I would suspect that the relative balance of U.S.S.R.—U.S. effort is, or has been, more unfavorable to us in the field of submarines than in the field of space activity.

M/R's Proposal

1. Recognize as national policy that we are in a strategic space race with Russia.
2. Establish pre-eminent strategic, tactical and defensive forces with representation from all goals;
   - Manned space platform—1965
   - A U.S. citizen on the moon—1967-68
   - Nuclear power for space exploration—1968-69
   - A spacecraft which can take off from earth, travel to and in space, return and land under its own power—1968-69.
3. Recognize that "space for peaceful purposes" is possible only if "freedom of space" is ensured; hence that the U.S. military must be given a predominant role in developing and carrying out the projects necessary to guarantee freedom of space.
4. Establish pre-eminent strategic, tactical and defensive forces with representation from all services.
5. Recognize the necessity of greater defense funding to accomplish this, including a supplemental budget in January, 1961, to make it possible to:
   - Speed up to a maximum degree the construction of ICBM launching bases, Polaris submarines and the Mach 3 missile-carrying B-70.
   - Provide the Army with funds to begin the immediate procurement of already-developed modern missiles, other weapons and airlift.
6. Establish further-on defense spending by need and not by budget ceiling.
7. Streamline defense regulations and procedures to make industry's role in the U.S. defense and space effort more effective.
8. Take what steps may be necessary to establish and promote national scientific objectives.
9. Re-establish decision-making in the U.S. defense and space organization.

Another way to look at this, of course, is that if the U.S.S.R. set out to deny space as a medium to the U.S., I believe we could make it terribly expensive for them for a relatively modest expenditure of our own, and I have seen no inclination on the part of the U.S.S.R. to indulge in those kinds of games.

By this discussion I don't mean to suggest that the U.S. military should not play a major role in developing and carrying out projects for applications in space. The individual projects, however, should be judged on the basis of their military utility in space and not simply on the basis of the prestige of being in space or the even more nebulous need of establishing our right to be there.

Most of the rest of your individual proposals bear on specific defense questions. I don't believe it would be useful or appropriate for me to comment on them individually. The combined space-defense area certainly provides many problems for government administration and program management in both government and industry. Most of the problems probably do not have perfect solutions and, of course, it is frequently too expensive pursue alternative courses. It is, therefc usually impossible to say, even in ret spect, that optimal arrangements h: been used. It is safer to assume that th is always room for improvement, and should seek it with all of our energy.

Publications such as yours have tremendous responsibility as organs communication and instruments of national conscience. I believe sincer you are doing a fine job in fulfilling th responsibilities. You have my very b wishes for your continued success.

Richard E. Horner
Northrop Corporat
Beverly Hills, Calif

Gov. Stresses Dedication

To the Editor:

I read with interest the Open Letter Senator Kennedy and the Vice Preside MISSILES AND ROCKETS is to be co gratulated for its forthright proposal.

No American can doubt the imperat for an accelerated development in the co quest of space. This will call for mo money and for a dedication of America to the idea that a "second class Americ is not good enough.

I have reservations, however, abc setting a timetable for the accomplishme of our objectives. If we fall short of o target date we are held up to internatior ridicule even if we succeed at a later da

What we need is not a time table, it a rededication to the greatness of Americ

What we need is not simply mo money. It is the desire on the part of t President to make that money produ for America.

Edmund G. Brown
Governor of Californ
Sacramento

Calls It Lobbying

To the Editor:

With respect to the nine-point proposa I cannot, in good conscience, participa in an exercise so obviously directed "lobbying" for one segment of our indu try.

A. W. Betts
Brig. General, USA
Director
Advanced Research Projec
Agency

For Quick Action

To the Editor:

I have read your article and wish t join you in the appeal for a frank discu sion and quick action.

Philip S. Morse, President
Morse Sewing Machine & Supply Cor
New York City

louse Group to Study FCC Move on Gigacycle Spectrum

T&T announces meantime that it hopes to launch a test ommunications satellite at private expense

Key members of the House Comerce Committee said this week the ommittee "certainly" will look into e FCC decision against reserving rt of the gigacycle spectrum for mmercial communications satellites.

Both Committee Chairman Oren arris (D-Ark.) and Rep. John Bennett R-Mich.), ranking minority member, id the committee will look into the ue after the congressional session ens in January.

The FCC issued a 6-1 decision Oct. to open the gigacycle spectrum—the icrowave spectrum above 890 megacles—to use by point-to-point comunication systems. A number of comon carriers had asked the FCC to fer action on the entire spectrum or serve several bands for use by comunications satellites.

Meantime, the American Telephone Telegraph Co. said it is negotiating ith telephone systems in Britain, rance and Germany with the hope of launching an experimental communications satellite in about a year.

The Bell Telephone satellite, weighing about 150 lbs., would be launched into an orbit of 2200 miles altitude. The vehicle would be a *Thor-Agena* provided by the National Aeronautics and Space Administration at a cost to the companies of about $4 million.

AT&T said that if launch facilities are made available as indicated by NASA Administrator T. Keith Glennan earlier this month, it and any other private companies interested would pay the entire cost of developing commercial satellite communications.

A company spokesman said AT&T's spending plans are not limited by the figure of $50 million previously given as the cost of an operational system of 30 satellites. Frederick R. Kappel, AT&T president, said that at its present spending rate the giant utility will plow $1 billion into R&D over the next decade.

---

lavy to Begin AUTEC Next Year

The Navy is understood to be planng to begin construction of its prosed Atlantic Underwater ASW test nge before the end of next year.

Cost of building the Atlantic Underater Test and Evaluation Center UTEC) is now reported to be estiated at about $100 million. That is 0 million more than earlier estimates.

No location has been chosen defitely.However, the Navy is underood to be negotiating with the British r use of Exuma Sound and Tongue the Ocean—deep, ideally-suited ater areas south and southeast of assau. (M/R, Aug. 1.)

The Naval Bureau of Ships held a eeting with several dozen interested ntractors earlier this month to ask r proposals on a half-million-dollar udy contract covering operation and sign of the range.

The proposals are reported to be e about mid-November. A contract expected in December. Results of the udy are expected about the middle of xt year.

Meantime, the Navy also is excted to award a contract for an eanographic survey of whatever area is selected for the range. Cost of the survey is expected to run about $2 million to $3 million.

The Navy is planning to construct the range over the next five to 10 years. Construction will be directed by the Bureau of Ships.

The range will give the Navy for the first time the capability of fully instrumenting the operation of such ASW missiles as the Goodyear *Subroc* under nearly wartime conditions.

Instrumentation planned for AUTEC will make it possible to obtain the same kind of data on underwater missile launchings that is now obtained on missiles that travel through the atmosphere and space.

At present, much of the test data obtained during R&D launchings of ASW missiles is considered crude at best.

For example, one method used for testing the Minneapolis-Honeywell *Asroc* is for a submarine commander to report whether his submarine has been hit by an *Asroc* launched from a surface ship. Hits are occasionally determined by subsequent examination of the submarine for paint scratches.

First Details of Avcoite Nose Cone Covering Given

Avcoite—an ablating material used to protect ICBM nose cones on atmospheric re-entry—is made up primarily of fuzed quartz and molybdenum honeycomb.

First mention of the composition of the hitherto secret material was made by Lt. Gen. Bernard Schriever who stated that the RVX 1-5 nose cone presented to the Smithsonian Institution was covered with a "quartz coating." This was the first nose cone to go the full ICBM range and be recovered to prove out the ablation theory of re-entry protection.

Still secret are details as to exact makeup, thickness, additives, etc. It is understood that the coverings can be produced in a wide variety of compositions to fit differing applications. The material was developed by Avco Research and Advanced Development Division.

In constructing the ablative nosecone coverings, the body was covered with a high-strength alloy (molybdenum) honeycomb and the interstices filled with the fuzed-quartz ceramic. As the body builds up friction heat in the atmosphere, the covering slowly melts away, carrying off the tremendous heat generated and protecting the missile payload. This was a vital problem in designing a successful long-range ballistic missile and its solution made possible a delivery system for nuclear warheads.

In presenting the RVX 1-5 to the Smithsonian for the Air Force, Gen. Schriever said it "represents an outstanding achievement in space science and technology, in every sense of the term." The nose cone will become a permanent part of the Institution's exhibit of historic vehicles in aviation and space science.

Hawaii ARS Section To Be Set Up by January

A Honolulu section of the American Rocket Society is expected to be chartered by next January. Twenty-five have already submitted applications for membership in this first ARS section in the fiftieth State.

Organization is being spearheaded by Capt. Mike Sellars, USN, past president of the Florida Section and ex-boss of the Navy's *Polaris* unit at Cape Canaveral.

Hawaii is rapidly gaining importance as a tracking and instrumentation center for the Pacific Missile Range and the U.S. space program.

The Missile/Space Week

Four Shots and a Scottish Port for Polaris

The *Polaris* submarine Patrick Henry is undergoing final checking for operational duty after a secret demonstration of her mighty war potential.

The 6000-ton nuclear-powered sub—second of the *Polaris* fleet—successfully launched four *Polaris* missiles in four attempts under nearly tactical conditions between Oct. 15 and 18 while submerged 500 miles east of Florida.

Meantime, the United States and Britain were reported to have completed secret negotiations for the use of a Scottish seaport as an overseas base for the *Polaris* sub fleet.

The unidentified port would be used for the most part by the *Polaris* tender Proteus. The Proteus will provide the nuclear-powered subs with fresh food, fresh crews and other supplies including spare missiles.

AF Builds Full-scale Dyna-Soar, B-70 Test Facility

The Air Force plans to have a full-scale heat-stress test facility for B-70's and *Dyna-Soars* operational by next January. The $7.7-million facility is being added to the present stress testing complex at the Wright Air Development Division near Dayton, Ohio.

Bomarc B Flies—the Air Force Buys

The Air Force will soon begin accepting deliveries of the Martin *Bomarc B* in quantity. More than 200 are scheduled to be deployed in the United States and Canada.

The Air Force officially accepted the *Bomarc B* for production on Oct. 13. The next day the 400-mile-range air defense missile ripped from its launcher at Eglin AFB, Fla., and intercepted an electronically simulated target 345 miles away over the Gulf of Mexico—the longest flight of a *Bomarc B* to date.

Minutemen May Dot South Dakota

The barren prairies around Ellsworth AFB, S.D., are expected to become the nation's second *Minuteman* base.

Surveys of the area are under way in advance of an Air Force request for authorization and funds.

So far, the Air Force has authorization and money only for building sites for the first three *Minuteman* squadrons around Malmstrom AFB, Mont. First of the three 50-missile squadrons is scheduled to be operational in mid-1962.

Missile Defense: Tests, Contracts, Advice

Activity in the complex and boggy field of missile defense cropped up in a number of places in recent days.

Item: The third-stage, small solid motor for Western Electric's *Nike-Zeus* underwent its first captive test firing Oct. 7 at Thiokol's Redstone Arsenal plant. It was successful. The unusual spherically-shaped motor will provide *Zeus*' nuclear-packing third stage with the ability to manuever in order to intercept an incoming ICBM warhead.

Item: Douglas picked up a $60 million contract from Bell Telephone for another year of R&D work on *Zeus*. The contract was Douglas' slice of the supplemental $199-million contract awarded Western Electric by the Army for the program.

Item: ARPA established a technical advisory group to provide recommendations for advanced missile defense systems. The group will be comprised of representatives of laboratories under contract to ARPA for Project *Defender*—ARPA's $110 million dollar advanced missile defense research program.

Committee to Watch for AF Duplication of Apollo

The House Space Committe
investigating possible duplication
tween the manned space flight pla
the Air Force and the National A
nautics and Space Administration

Chairman Overton Brooks (D-
reported that his committee is kee
a close watch on NASA's Pr
Apollo and an Air Force study b
last year by Aeronutronic Divi
Ford Motor Co.

Under Project *Apollo*, NASA p
to award by Nov. 14 two or three
tracts for six-month feasibility stu
of a three-man space ship that c
orbit the earth and make a circumlu
flight. The current NASA budget
cludes $1 million for the contracts

Brooks said the $161,000 A
nutronic study, now nearing com
tion, is concerned with the struc
of a three-man vehicle that would
main in orbit for extended periods
time.

In a statement Sept. 19, Aero
tronic said the 18-month guide
study authorized by Wright Air De
opment Division, Air Research
Development Command, covers pro
ing structural configurations that
be applied to "very advanced Air F
vehicles."

• **Conflict denied**—Last week,
Ford spokesman emphasized that
work is on structure only, and d
not conflict with the overall syst
study required for Project *Apollo*.
noted that Aeronutronic is on a te
with North American Aviation bidd
for an *Apollo* contract.

Brooks said there had been rep
that the concept involved in the Ae
nutronic study is quite similar to t
of *Apollo*. "If so," he continued, "
two agencies should work together
the interest of saving both time a
money."

A NASA spokesman said the
agencies are cooperating. At the
quest of the Air Force, he said,
NASA structures engineer from La
ley Research Center helped evaluate
dustry proposals.

The Air Force said NASA scienti
and engineers were kept fully inform
of progress and results; by means
discussions and symposia. The
Force emphasized that the studies co
cerned structures only, and did n
consider overall system parameters.

In its September statement, Fo
said that, following structural tes
it will build a working model of t
space structure designed in the stud

The structure, a stiffened cylindric
shell of double-wall construction, cou
act as shield against solar and cosm
radiation and meteoric impacts.

xplorer VII Still Sends fter Cut-off Timer Fails

Explorer VII, the so-called “radia- on satellite” launched Oct. 13, 1959, crowding the 20-megacycle band with nwanted information because a transis- rized timer failed to cut off transmis- ons after a year.

The signal, from one of two trans- itters originally installed, is providing formation on two experiments and mperature measurements in various rts of the satellite. A tracking beacon 108 mc failed last Dec. 5 when its emical batteries became exhausted. he best hope for clearing the 20-mc annel seems to be a component fail- e or loss of power from the solar cells wering the transmitter.

The two experiments for which data still coming are the cosmic ray easurement designed by Dr. James . Van Allen of the State University Iowa and the earth infrared heat lance measurement designed by Dr. erner E. Suomi of the University of isconsin.

• **Mysterious failure**—At a press nference Oct. 14, the day after the ner was to shut off the transmitter, ans J. Fichtner of the NASA Mar- all Space Flight Center, Huntsville, la., said he did not know why the ner failed to operate. It was built for e Marshall Center, at that time a vision of the Army Ballistic Missile gency, by the Bulova Research and evelopment Labs.

Fitchner reported that Bulova built e timer, a 2½-in. cube, on a crash sis in two months from the time e contract was awarded in February, 59. The timer was tested for vibration d environment and, later, in a cuum. However, there was not time r the full year's test to prove it out yond the shadow of a doubt.

Fichtner bristled when an M/R itor asked whether spending a year ssing through the heaviest portion of e Van Allen belt might have damaged e timer's transistors enough to cause ilure. He said an experiment aboard e satellite designed by Huntsville per- nnel showed that radiation does not mage a solar cell. Thus, he con- ded, the same level of radiation could t have damaged transistors in a rela- ely shielded internal location.

• **Data gained**—These scientific re- lts from *Explorer VII* were reported:

–The first proof that a solar flare umps” electrons from the outer Van llen belt into the atmosphere came st Nov. 28 when the satellite passed er the top of an aurora in Montana. was the first time a satellite with radiation detectors passed over an aurora at the same time a man was below, photographing it.

Dr. Brian O'Brien, an aide to Van Allen, said that on the corresponding pass, the next night, most of the particles had gone from the radiation belt.

–A surprising and so far unexplained indication that the flux of primary cosmic particles with atomic number 6 or higher and energy upwards of 1.5 million electron volts is greater on the dark side of the earth than in sunlight.

Dr. Philip Schwed of the Research Institute of Advanced Studies, Baltimore, said the result is still tentative but there is indication that the flux is 50% greater on the dark side. He said the detector, which rejects all nuclei and nuclear particles of lower atomic number than 6, responds in the most intense portion of the lower Van Allen belt. Researchers are trying to determine why.

–The total heat flow to and from the earth is being reconstructed from data provided by two bolometers coated so they would respond differently to heat radiation. Rough comparisons have been made with the weather maps for corresponding days.

Dr. Suomi said the data on this experiment is about half processed, but data analysis is just beginning.

Revolution in Production Of Stainless Steel Strips

A revolution in stainless strip steel manufacture is under way at Wallingford Steel Co., Wallingford, Conn.

For the first time, thickness variations across the width of steel strip can be held to less than 0.0005 in. on a production basis.

The innovation is an abrasive belt grinding line with a unique crown grinding feature. The line replaces two former grinding lines which included five machines and reduces the three shift operation to one with an improvement in quality.

The two grinders, with their coated abrasives running in a flood of sulfurchlorinated oil, were built by the Hill Acme Co. from designs modified by Abrasives engineers of Behr-Manning Co., division of Norton Co., Wallingford and Allegheny Ludlum Steel Corp. also cooperated in the development.

Savings of over $91,000 per year will result from reduced labor and abrasive belt costs alone. Another economy is the ability to salvage entire coil.

Solids Advance

NASA Awards Contracts And Schedules Shots

by Jay Holmes

SOLID-PROPELLANT rocketry advanced on a broad front last week at the National Aeronautics and Space Administration. These developments took place in rapid succession:

–Preliminary design contracts were awarded to three companies for six-month paper studies of solid boosters of 1 to 7 million lbs. gross weight, with thrusts of 2 to 3 times that weight.

–A $6 million one-year prime contract was awarded to Chance Vought Aircraft, which adds final assembly and launching to its responsibilities in the development of the *Scout* launch vehicle.

–NASA said the next *Scout* shot, an attempt at orbit, will take place before the end of the year.

–The new *Iris* sounding rocket, a 1 and ½-stage vehicle costing about half as much as a partly liquid competitor, scored its second straight success by lifting 125 bs. of instruments to an altitude of 140 miles and 230 miles downrange from Walops Island, Va. One flight remains in the *Iris* qualification series.

The solid booster contracts, totaling $225,000, went to Aerojet-General, Grand Central and Thiokol. Grand Central will design a booster in the 1 million lb. class, Thiokol in the 7 million lb. class, and Aerojet one in each class.

The NASA program is aimed at learning whether a big solid R&D program can be carried out within the limits of NASA funding. This contrasts with an Air Force study begun by Aerojet last spring to determine whether a big solid booster is feasible at all, with cost a secondary question.

A decision on going into an R&D program on a big solid booster is conceivable after the completion of the three studies. However, it is also possible another round of studies might go into such detailed questions as nozzle design, ignition, and logistics. Since any big solid booster would compete with *Saturn*, a go-ahead probably would require White House approval.

In the *Scout* program, Chance Vought formerly had responsibility for only the launch tower fabrication and manufacture of airframes and motor transition sections, which it also supplies for the Air Force *Blue Scout*. Aeronutronic Division of Ford Motor Co. has the prime on *Blue Scout*.

NASA declined to say how many *Scout* vehicles are involved in the Chance Vought contract.

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echnical Countdown

ELECTRONICS

ur For The Price of One

A multi-polarized antenna, whose elements resemble a altese Cross, has been developed by Chance Vought. It es the work of four separate units. Remote switching or tomatic selection for instant response gives the system mplete polarization coverage for tracking, telemetering, or mmand control. The system costs the same as conven- nal helical arrays, but is one fourth their size and is de- ribed as having lightweight, low-drag design. The unit ll be installed aboard USNS Range Tracker, a tracking ssel for the Pacific Missile Range, which is being instru- ented by Chance Vought.

ot Too Little, Just Too Late

Armour Research Foundation has just made available oceedings of the Annual Computer Applications Sym- sium held during October—last year, that is. It is para- xical that it took one year to disseminate these details of vanced programing and operating techniques and state-of- e-art discussion—in an industry which is not only the stest growing in the world but one in which speed itself is paramount virtue.

ckets to Aid Geodesy

A new Air Force project for exact measurement of rth distances will be carried out by launching a series of flash cartridges. These will ignite in rapid succession at itudes up to 1000 miles. Observation from widely scat- ed points will provide distance calculations by triangula- n. Launchings of Aerolab *Argo D-8* sounding rockets m Wallops Island, Va., are tentatively scheduled for nuary. For lower acceleration and longer burning, rockets ll be modified by substituting a *Yardbird* for *Recruit* urth stage and a baby *Sergeant* for the T-55 fifth stage.

nsitive Tube Photographs Cosmic Rays

A new electronic tube developed by Westinghouse is so nsitive it can "see" individual particles of light. The tracon tube is being used to photograph the tracks of smic rays as they move at speeds near the velocity of ht through a solid crystal.

easurement Handbook Available Soon

A new handbook on precision measurement and cali- ation will be issued soon by the National Bureau of ndards. The compilation, called Handbook 77, lists in ee volumes all important NBS publications in the areas electricity and electronics, heat and mechanics, and tics, meteorology, and radiation.

mog Scatter' for Communications

A Hughes Aircraft engineer has found that the tempera- e inversion layer responsible for Los Angeles smog can used to aid VHF radio transmission over long distances. e ham operator has successfully transmitted signals on 144 and 222 mc bands from California to Hawaii—a ord distance of 2540 miles—with the technique.

Tunnel Transistor in Development

Cal Tech scientists are reportedly at work on a "tunnel transistor." Even though it doesn't work too well yet, researchers are optimistic that the device has a potential operating range in the high-gigacycle frequencies.

Reds Develop Electromagnetic Rock-Crusher

Disintegration of rocks by electromagnetic waves reportedly has been demonstrated by Russian mining engineers. The report does not specify the distances from which the device operates.

GROUND SUPPORT EQUIPMENT

Nuclear-Powered Radar Being Built

The world's first nuclear-powered radar unit is being built near Sundance, Wyo., for the AF Air Defense Command. The $6-million installation—possible forerunner of many such power sources for remote locations—is scheduled to be in operation in 1962.

ADVANCED MATERIALS

Russians Used Nuclear Emulsions

Blocks of thick, layered nuclear emulsions, weighing about 60 kg, were carried into space and returned in Russia's second "spaceship" last August. In one of the photoemulsion blocks, provisions were made for developing the emulsion while in flight.

New Teflon Can be Cemented

DuPont has developed a new type of Teflon film, one side of which is cementable with ordinary adhesives. This supplants earlier methods, which involved treatment with alkali metals in organic media for adhesive receptiveness or heat sealing and bonding for lamination.

Columbium Alloy Fusion Welded

A columbium-base alloy, containing 32% tantalum, is being welded and machined by Ling-Temco Electronics Inc., in connection with the Air Force's Refractory Metals Structural Development Program. The alloy, a product of Fansteel, retains usable structural properties up to 2500°F.

OAO to Have Titanium Skin

The 1½-ton Orbiting Astronomical Observatory Grumman is developing for NASA will have titanium skin and aluminum interior construction.

PROPULSION

Mauler Propellant Contract Awarded

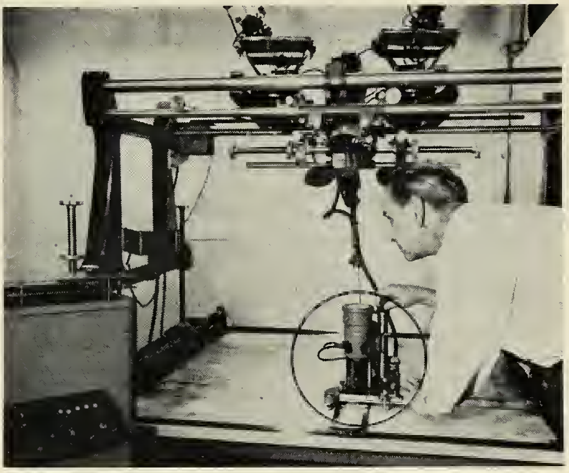
Grand Central Rocket will develop the propulsion system for *Mauler,* the Army's mobile surface-to-air missile, under a $643,000 subcontract with Convair/Pomona.

Centaur Testing Starts This Winter

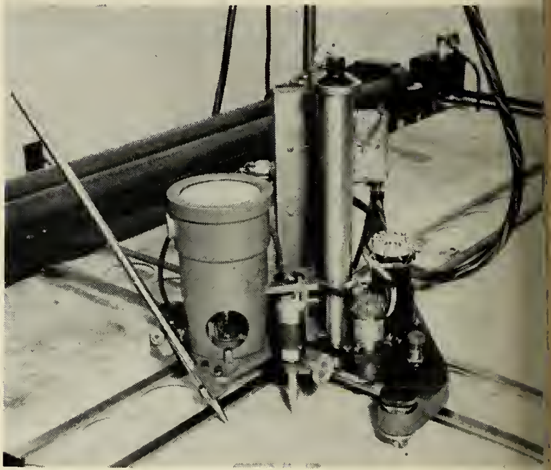
Convair plans to start *Centaur* static testing this winter, for flight tests beginning next spring. Planning calls for two restarts of the liquid hydrogen-LOX powerplant during each mission.

'Stereomat' to Speed Photo Conversio

Canadian's invention for processing aerial photos into maps called major development in field of photogrammetry



VIEW OF AUTOMATIC stereoplotting device installed on Nistri Photomapper. The electronics console is at the lower left, the optical duplexers are at the top of the photograph.



CLOSE-UP OF C.R.T. scanning head and tracing device. Imag seen on the tube face are correlated by detecting points in th stereos that have similar density characteristics.

by William Beller

A MAJOR SPEEDUP in processing photographic reconnaissance data now appears possible—just in time to handle an expected flood of material from *Samos* and new aerial surveillance systems.

For the first time, chart and map-making from photographs can be converted from laborious "hand work" to an automated process through the invention of a Canadian engineer.

With this new invention raw aerial photographs may be turned into maps —in as little as one-twentieth the time a qualified technician takes.

Cartographers are hailing this development as the most exciting since the advent of aerial photography itself. The reason is that they are frighteningly short of means to process data. In a single day's flight, a reconnaissance aircraft can take enough pictures to keep a major map-making service busy for almost a year.

Just to extract the information from one pair of aerial photographs takes an operator from 20 to 40 hours. It is no wonder that national mapping organizations are laboring under backlogged loads of urgently needed maps that are still years from being made.

- **One-twentieth the effort**—The inventor of the "Stereomat," the device that is expected to revolutionize cartographic techniques, is electrical engineer Gilbert L. Hobrough of Hunting Associates Ltd., Toronto. He is co-inventor of the Airborne Profile Recorder (APR), also classed as a fundamental contribution to photogrammetry. When installed in an aircraft, the APR determines and draws the terrain over which it is flying.

"Hobrough has given as much or more than any of his contemporaries to the field of photogrammetry," says Charles Spooner, Chief of Department of Advanced Research of the Geodesy Intelligence Mapping R&D Agency (GIMRADA) under the Army Corps of Engineers.

Labeling the Stereomat "a major and fundamental contribution in the technique of photogrammetric engineering," Spooner illustrates its value by noting that the development "should decrease the number of man-hours currently expended to extract contour information from aerial photographs by a factor of approximately 20.

- **The old method**—The way contours and profiles are usually derive from aerial photographs is this: A pai of photographs, which show a give terrain at slightly different angles, ar examined stereoscopically. This is easil managed by the technique of wearin glasses with different colored lense through which a composite of the tw photographs is viewed, each photograph being the color of one of th lenses. This may be remembered as th way one sees "3-D" movies.

In practice, the photographs are firs made into transparencies through whic the appropriately colored lights ar passed and then combined to form joint image on a platen below. Whe first seen, this image has two kinds o parallax in it, brought about by the si degrees of freedom of the photographing aircraft. By suitably orienting th projectors of the colored lights wit their associated transparencies, technicians remove all parallax except tha coming from the contour of the lan itself. This is called the "x-parallax.'

Since the x-parallax is a functio of the altitude, its removal by an apropriate raising or lowering of the laten is a measure of the altitude of e neighborhood being examined. In is way—by height adjustments of the laten—aerial photographs are conoured and profiled and the data used or building maps.

This process is still held by many eople to be a subjective one, dependng on a person's seeing two slightly iffering images and then combining em in the brain to form a single tereoscopic vision. The act of "combinng them" in the brain is believed to e a psychological one and therefore ne that can not be automated.

• **The new method**—Hobrough deolishes the Gordian knot in the folowing fashion. Electronically, he scans e same neighborhood on each of two erial photographs making up the stereo nage. Thus, the *x*-parallax between e two is perceived. It is removed in manner similar to the way a human perator would remove it, by raising r lowering an analog of a platen. ince the travel of the platen is a easure of the altitude of the neighorhood, the contouring or profiling of e area can be made to proceed autoatically.

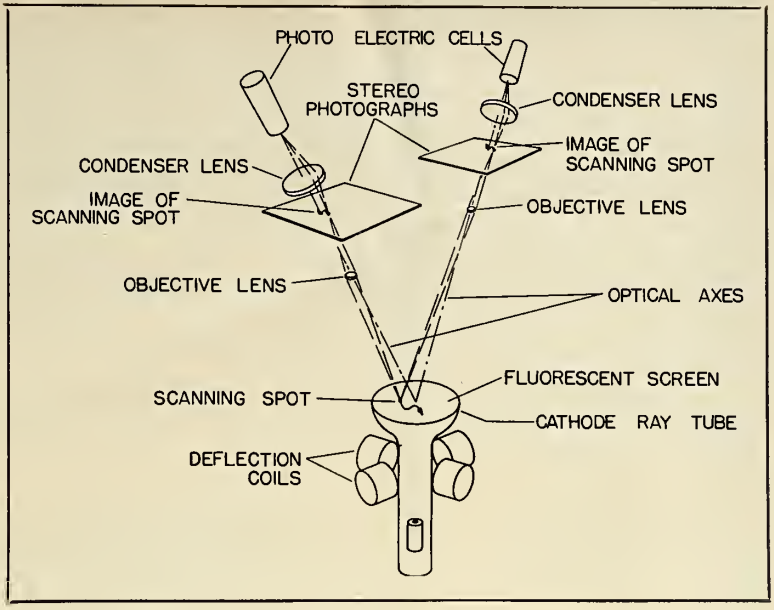
In automating the process, Horough turns it upside down. The laten becomes the light source, and vo photoelectric cells acting in comination become the receivers of the tereo image.

The light source is a scanning spot f light on the face of a cathode ray ıbe. The spot is produced by an elecon beam hitting the tube's fluorescent creen. Motion of the beam is conolled by voltages applied to external eflection coils. Like the platen, the RT can be raised or lowered.

The two stereo transparencies are ıspended at a small angle to each ther above the tube. They are adısted in space so that an objective ns below each will be directing the ght from the scanning spot onto the ame neighborhoods in the transparenies. After passing through the transarencies, the now attenuated and paterned light is gathered by condenser nses and sent into the photoelectric ells. Here, electric signals are genrated whose differencies are subseuently correlated and translated into n *x*-parallax.

The CRT is then appropriately oved up or down by servos until the arallax is eliminated. Thus the altide of the neighborhood is determined —"twice as accurately as a technician an," avers Spooner.

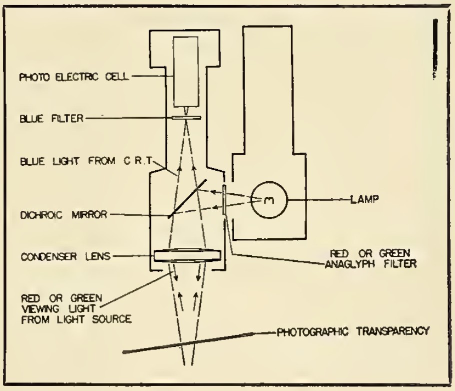
• **Army's buying another**—Colonel eonard L. Haseman, Director of IMRADA (Fort Belvoir, Va.), has een evaluating the Stereomat since is past August when his organization



ABOVE: Scanning spot of light examines the same neighborhood on pair of stereo photographs.

RIGHT: Optical duplexer. An anaglyph image projected on face of C.R.T. lets operator see area being "viewed."

BELOW: Block diagram of complete Stereomat arranged for "normal mode" operation, including orientation.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RED OR GREEN ANAGLYPH FILTER
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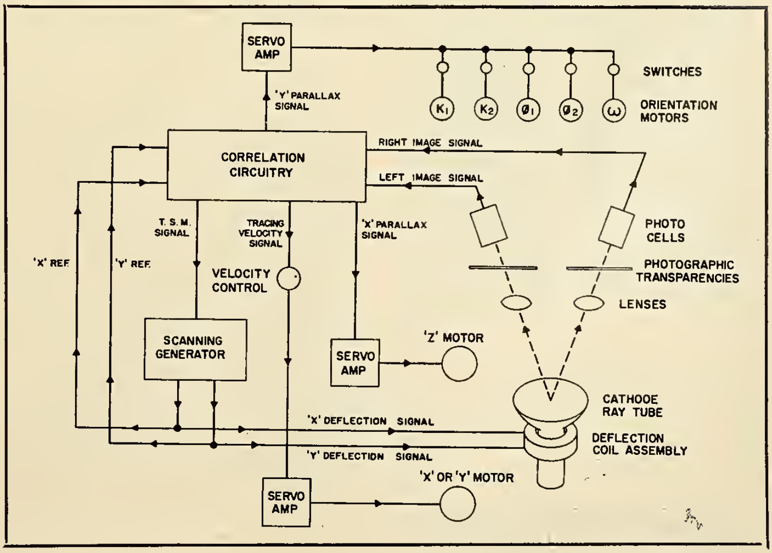

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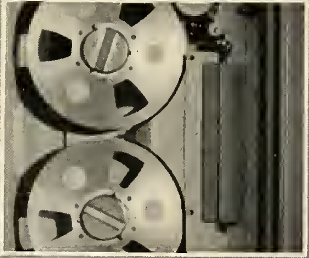

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received a pilot model, probably the only model made so far for sale. Kent T. Yoritomo, GIMRADA project engineer for Stereomat, reports running the profiling speeds up to 53 mm/sec, and the contouring speeds up to 39 mm/sec. Even at these high speeds, the results showed no decrease in accuracy with respect to a human operator's results, which come at about 8 mm/sec.

The results quoted fall in line with the accepted estimates that for a given accuracy the Stereomat can do contouring 4 times faster, and profiling 6 times faster than a human operator.

Theoretically, these figures can be raised to a ratio of 100:1. However, it is felt that the mass and inertia of the system would halt advancements beyond the 20:1 mark.

It is clear, then, why Colonel Haseman joins the general enthusiasm and calls the development "very interesting," and admits that "We're very pleased." He has already called for a more advanced model, one that would eliminate the "bugs" found in the present one.

The system has its limitations. It runs into problems when dealing with very steep slopes, with horizontal plane areas and with redundant observations—but so do human operators. The machine is confused by trees and by buildings. Neither can the present device plot planimetric details automatically. Its biggest problem would be having to establish the profile of Manhattan's skyline.

In July, the National Research Council of Canada observed that "there is no doubt that the device . . . presents the first and most successful attempt towards automatic stereoplotting." There are drawbacks, the investigators admitted: for example, the limited light energy supplied by the projection system is a serious limitation that has direct bearing on the accuracy and speed of automatic operations.

NRC softened its criticism by adding that "the repeatability and the accuracy of determination of spot elevations is remarkable."

• **Domestic Stereomat** — Hunting Associates has assigned world-wide manufacturing and sales rights for Stereomat to Benson-Lehner Corp. of Los Angeles. As a result, GIMRADA has awarded Benson-Lehner an advanced development contract for devising means for hastening production of "urgently needed" maps. Subcontractors are being negotiated with Hunting Associates, which will be continuing its automatic stereo work; the Zeiss Co. in Germany, which will be developing instrumentation for aerial triangulation; and the Wild Co. of Switzerland, which will be developing photogrammetr plotting instruments.

It is reported that a Stereomat h been ordered by USAF for its A Research and Development Comman Research Center at Rome, New Yor

If the device proceeds to live u to the hallelujahs that is greeting i then stereo-plotting machine operato will find themselves relieved of muc of their detail work; they will be abl to concentrate more on interpreti functions of which there are man

Hobrough expects that the gre capacity of automatic methods will lea to a new disposition of photogrammetric and cartographic facilities. Thu he envisions data reduction center where cartographic data would be processed. The next big problem—and monstrous one—would be how to stor and retrieve the enormous amount o image data that lunar and planetar photography will soon be giving us.

Weather Bureau Sets Up Special Mercury Office

The U.S. Weather Bureau ha established an office to provide specia forecasts for the Project *Mercury* man in-space program.

The group, at Suitland, Md., adjoining the National Meteorologica Center, will forecast winds, state of th sea, cloudiness and visibility for area beneath the proposed orbit, wit emphasis on planned recovery areas i the central Atlantic.

The Suitland group will have unit at Cape Canaveral and the Nationa Hurricane Center in Miami. The group will also supply climatological and meteorological guidance for designing future rocket and spacecraft systems.

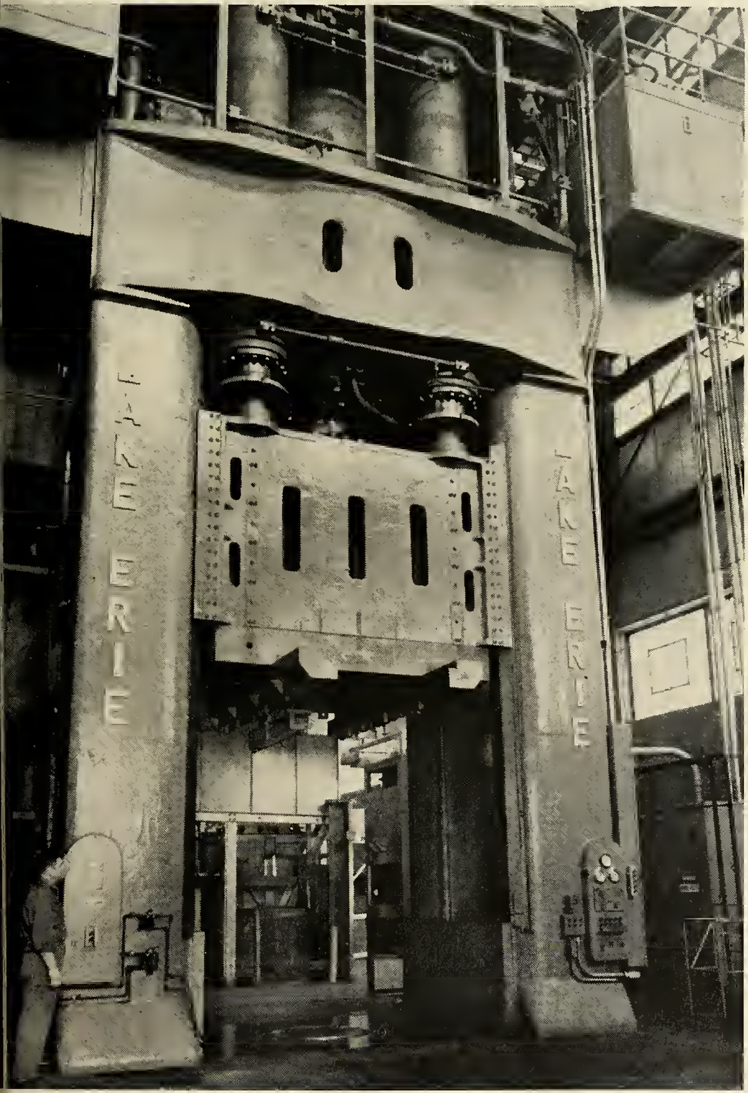
The seven-man Miami unit will develop methods for preparing and transmitting composites of weather radar pictures in the Florida and Caribbean areas, for use in predicting weather in launch and recovery zones. During operational periods, it will prepare and transmit to the Cape the Atlantic outlooks and forecast. Composite radar pictures of Florida and the near Atlantic will be transmitted by facsimile.

The four-man Suitland staff will collect weather information from other areas of the world between the 35th parallels. For most of the Northern Hemisphere, such information is received as a routine. Arrangements will be made to have special surface and upper air analyses sent from other centers in Africa, Australia and the Western Pacific. If a weather satellite is in operation, it will be a primary tool.

The Suitland staff also will develop procedures for using manned orbital flight as a scientific tool.

Lyon Ready to 'Flood' Navy with One-piece Polaris Cases

Veteran firm will use unique hot cup-cold draw technique which has many advantages including the complete elimination of welds in critical areas



UBLE-ACTING hydraulic press at Lyon is the largest of its kind in the United tes. It was designed specifically for close-tolerance deep drawing.

by John Judge

DETROIT, MICH.—An energetic metal fabricator is tooling up for high speed volume production of one-piece *Polaris* motor cases.

Lyon Inc., will use its unique hot cup-cold draw process for the job and, says Wayne Martin, chief engineer R&D, they can ". . . flood the Navy with production cases."

Backed by years of experience in high quality-low cost ordnance items, and an extensive practical knowledge of the metals involved, Lyon is no newcomer to the missile case field. The development of one piece rocket engine cases has been demonstrated—dimensionally, metallurgically and ballistically.

Production centers around a 5000 ton press, designed for the close tolerance, deep drawing of steel. Part of the system includes large salt-bath annealing furnaces and cleaning, pickeling and phosphate coating tanks.

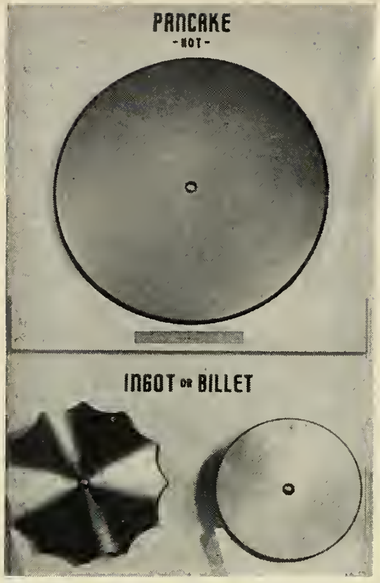
The final element is a production crew as well trained in each other's tasks as they are in their own. This last is an added guarantee of continuous production to the end of the $1.4 million Navy contract.

• **No joints**—The greatest single advantage of the deep drawn cases is the total elimination of welds in critical areas. This eliminates the time consuming welding itself along with the detailed inspection processes involved.

Other advantages from the method include a lessening of the criticality of non-metallic inclusions and a reduction in the amount of discarded scrap for each case.

There are also some less obvious benefits accruing to the process.

The Lyon method eliminates dependence on flat steel stock. Instead, the disc that serves as the blank, from which the case is drawn, is obtained



PANCAKE pressed from machined ingot results in formation of radial flow lines ideal for deep drawing.

EXPERIMENTAL motor chamber was drawn with integral ribs. This allowed simple, accurate attachment of fins.

from the ingot itself by hot pressing. Thus every ingot producing steel company is a potential source of supply.

A further advantage from this method is that the surface imperfections are machined away before pancake pressing. In addition, the "as cast" structure of the ingot section flows uniformly into a flat disc according to a definite procedure.

The metal in actual contact with the faces of the upper and lower dies does not flow but transmits the pressure in an axial direction to the center of the ingot section. This force is transmitted in a radial manner from the midsection to the outer edge giving the pancaked blank radial flow lines.

This is the most ideal condition for deep drawing. In fact, this transmission of the pressing effect through the center of mass of the ingot is a prime factor in the success of the deep drawing operations.

Lyon's deep draw techniques have been applied to low drag bomb casings. Martin points out that same procedure is aptly suited to the fabrication of one-piece solid rocket motor chambers.

Ignoring the type of steel involved and hence the numerical temperature data, the Lyon deep draw process can be outlined in general, using the bomb casing as an example.

• **Low drag bomb parallel**—In the pancake forming operation, the machined ingot is brought up to working temperature in a salt bath. Upon completion, the pancaked disc is transferred swiftly to a cupping die to take advantage of the heat still contained in the workpiece.

After formation of the cup, it is immediately placed in a furnace to bring it to temperature for the first drawing operation. This fast transfer of the workpiece permits the utilization of the heat remaining in the body to shorten the process time for the first hot draw.

As far as the bomb casing is concerned, the piece is hot enough after the first draw to permit annealing without reheating. After quenching, pickeling and lubrication with phosphate, the second and third drawing operations are performed cold. For the 500 lb. bomb, the tonnages required were 1475 and 1300 tons.

In the third draw, the bomb is drawn all the way through the die for the last time. The fourth draw is cold and the body is drawn to a definite length through the die, retaining a portion of the thickness left by the third draw. On the return stroke of the press, a knock-out in the bottom pushes the bomb body back up through the die.

Lyon then headed the bottom of the body into a shape that allowed utilization of the center for the base plug instead of being scrapped.

After trimming, the mouth end of the body was annealed for a distance of 5 in. and phosphate coating applied. The mouth anneal is necessary for the fifth draw, since the top part of the die is tapered to give a developed form to the upper sidewall at the mouth end and a uniform taper for the ogive after nosing.

After the fifth draw and final trimming, the bomb body is mouth-annealed for a distance of 9 in. and completely lubricated.

Then one stroke of the press p forms three distinct operations. Redra where the tapered outside section pushed to the inside of the case; ba taper, where the base of the case pushed to a definite stop; and first n ing, where the ogive is formed with uniformed tapered wall section by to nage alone.

Finally there is a small amount machining and a heat treat step to o tain the desired physical properties.

Lyon's first venture into rocket cas came in the latter part of 1956 wh the U.S. Naval Ordnance Test Stati (China Lake) contracted for one-pie deep drawn chambers. These were a proximately 12 in. in diameter a about 57 in. long.

An independent venture resulted the successful drawing of integral ri on engine cases which allowed a simpl but accurate means of attaching fins.

• **Alloy familiarization**—Lyon h completed material fabrication inves gations showing the adaptability several alloy steels to the hot cup-co draw method for cases. These alloys a 4140, 5% Chromium, High Silicon a AMS 6434 (Mod). All of these allo have been hot pancaked, hot cupp and cold drawn without difficulty.

The same type of study was appli to Tricent (300-M) with like results.

Engine cases manufactured by t deep draw method from one or more the above alloys contained physic properties that exceeded 250,000 p yield strength, 325,000 psi ultima burst and 8 to 10% elongation.

These properties were determin through internal hydrostatic pressu stress analysis tests using both the stre coat and electrical resistance stra gages. The yield and burst data w obtained on one piece, cases, 12 in. 56 in. with a wall thickness of 0.100 i

In the case of each and every allo Lyon conducted an exhaustive series tests on a laboratory scale from t ingot on up through the final produ before committing one workpiece to t big press.

These studies were verified by the close correlation to the actual full sca deep draw process. Lyon has also den onstrated its deep draw ability with T Ladish Co.'s D-6 alloy compositio The 5% chromium alloy is similar Vascojet 1000. Lyon's familiarity wi these compositions is such that the bur level and point can be predicted wi accuracy.

The press itself is a Lake Erie 500 ton double acting, hydraulic affair wit 160 in. of daylight and 120 in. stroke. It has a capability of drawin items up to 40 in. diameter, and 106 i long or up to 80 in. diameter and 7 in. long.

High-intensity Cryogenic Magnet to Weigh 50 lbs.

Designs for an electromagnet with a 100,000 gauss field intensity but weighing only 50 lbs. are being proposed by scientists at the National Bureau of Standards Boulder Laboratories, Boulder, Colo.

The magnet would employ seven stacked "flat doughnut" coils of aluminum foil operating at liquid hydrogen temperatures. Each coil measures 11 in. across with a 3-in. cylindrical hole in the center. The coils would be separated from each other by insulated ribs and connected electrically in series.

The design departs from the traditional approach. If past experience were to be the guiding factor, such a magnet operating at room temperature and throughout the same volume would weigh tons. Its power requirements would approximate the demand of a city of 40,000 people—some 7 million watts. This is 2000 times the power needs of the proposed magnet.

The low-power, steady-state magnet was designed by John Purcell and Errol G. Payne of the NBS Cryogenic Engineering Laboratory.

Aluminum was chosen because, if pure, its resistance in cryogenic temperatures is lower than all normal conductors except sodium. This low resistance, plus the gain from the stacking design, make possible intense magnetic fields over a cylindrical volume 3 in. in diameter and 8 in. long.

When completed, the pilot magnet will be used to study properties of materials at various temperature levels.

AEC Member Denies U.S. Covets Congolese Uranium

A member of the Atomic Energy Commission indicated last week the United States is no longer vitally interested in Congo uranium.

Commissioner L. K. Olson told the American Mining Congress at Las Vegas that the Shinkolobwe uranium mine in Katanga Province has been exhausted and was closed last April, months before the Congo attained independence.

Olson was commenting on recent remarks by Patrice Lumumba, the pro-Soviet sometime Congo leader, who said troubles in Katanga were caused by U.S. interest in uranium. Olson said he understood the mine at the time of the disturbances was still operating to clean up existing stocks.

The commissioner, in a review of the uranium purchase program, recalled that buying in the U.S. and Canada has been cut back as a result of reduced requirements, although he said the long-term prospects are good.

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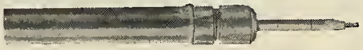

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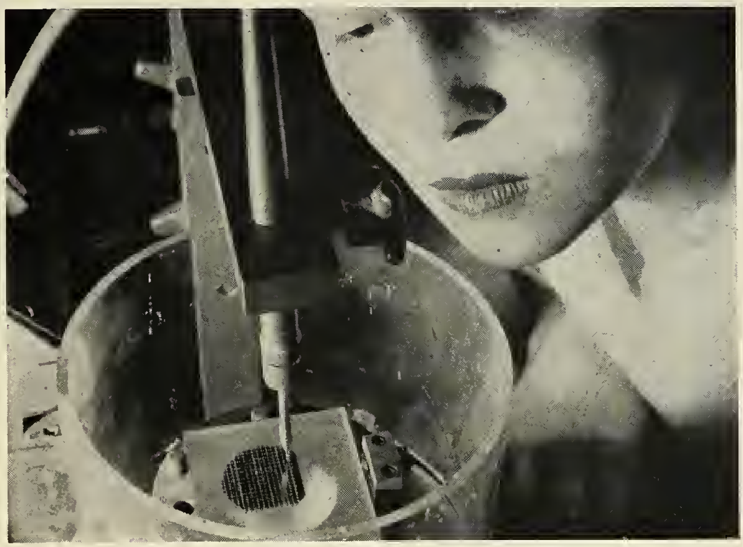

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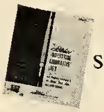

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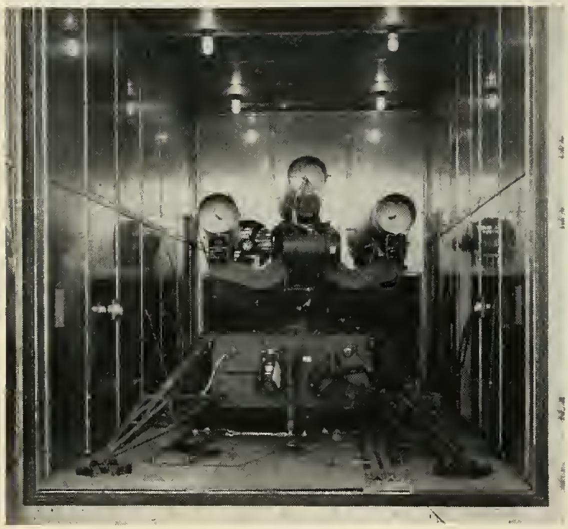
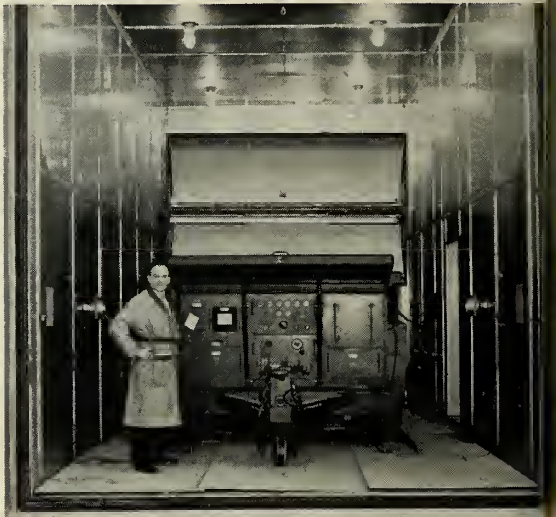
Painstaking Environmental Tests A

Raytheon's huge test chambers at Andover subject missiles and their transport and support systems to extreme physical punishment





A COMPLETE LAUNCHER (left) with three dummy Hawk missiles fits easily into this temperature-humidity test chamber at Raytheon's Andover Environment Lab. (Right) The ent
CW acquisition radar is housed in the same climatic facil

by Charles D. LaFond

EXHAUSTIVE AND COMPLETE environmental testing of the Army's *Hawk* surface-to-air missile system has played a dominant role in its broad acceptance as an unusually reliable mobile weapon.

To assure its continued use and to support its proponents faith with higher performance and even better reliability over the years, Raytheon Company has steadily expanded its Andover, Mass., Environmental Laboratory. With its giant test chambers entire missiles, launchers, or electronic support systems are being subjected to every possible combination of physical misery as a part of the normal production routine.

End result, says Raytheon who has been prime contractor for *Hawk* development and production since 1956, is a tactical weapon capable of transport by any mode and of operation anywhere in the world.

Designed primarily for defense against low level attack aircraft, the *Hawk* surpassed all of its early operational requirements.

In November, 1958, it successfully destroyed the supersonic Lockheed XQ-5 ramjet target missile. In January of this year it performed the first known intercept of a ballistic missile when it was launched against the Army's *Honest John* surface-to-surface artillery missile. Combined speed at impact was nearly Mach 3.

The Army and the Marine Corps will make broad use of the *Hawk* system. For continued R&D for ground support equipment, the Army's Boston Ordnance District recently awarded Raytheon $10.5 million. On Sept. 30, 1960, this same agency awarded the company four letter contracts for $29 million for continued production of *Hawk* missiles, electronic support systems, and engineering services.

First overseas use of operational *Hawk* units by the Army will be in Okinawa and the Panama Canal Zone.

The Marine Corps has announced activation of its first *Hawk* missile battalion at Twenty-nine Palms, Ca
With four firing batteries plus he
quarters and service battery, the 6
man unit is already equipped and
undergoing intensive training.

For NATO use, Raytheon has
censed SETEL (La Societé Europée
de Téléguidage) in Europe to bu
Hawk missiles. SETEL serves to
ordinate the industrial output of f
manufacturers—one each from G
many, Italy, Belgium, Holland a
France—who will individually produ
portions of the system. Raytheon
assist in setting up their production li
and also will supply some portions
the GSE.

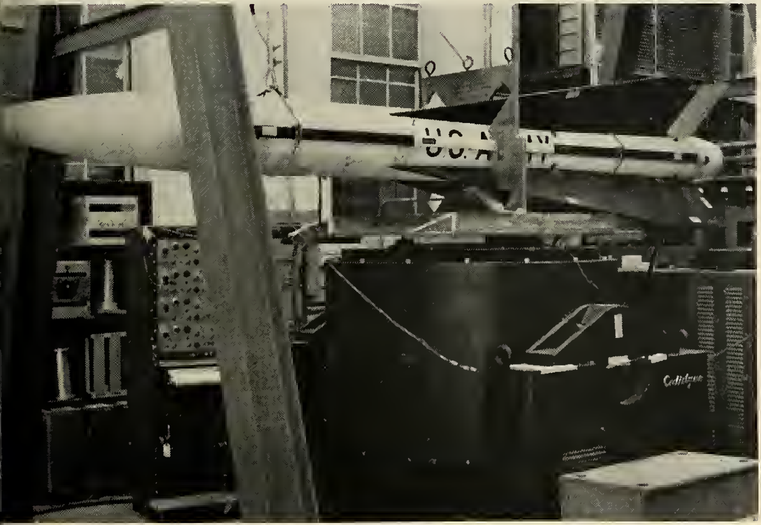
• **Testing role increases**—The r
of environmental testing for such m
siles as the *Hawk* has become incre
ingly important in recent years, unti
has become an integral part of the p
duction of any weapon system ma
factured today. It is destined for e
greater emphasis in the future.

A highly mobile missile system s
as *Hawk* must be capable of operat

ey to Hawk Reliability

→

POPULAR HAWK will be used by Army, Marines, NATO.



AWK missile undergoes vibration testing with 15,000-force-pound shaker as a part of ormal production environmental test program.

nder the environmental conditions ound in any part of the world. The auncher and the missile also must withtand extreme vibration and shock orces at launch and the missile must unction under extremes of temperaure, acceleration, vibration, and altiude during its flight.

The *Hawk* system's mobility also exoses it to severe transportation enironments. Being transportable by ship, anding craft, helicopter, rail, aircraft, r truck, it is subject to a wide variety f vibration and shock.

To assure reliability and effectiveess of the *Hawk* system in every transort and operating environment, the nvironmental Laboratory at Raythen's Andover Plant was established.

While environmental testing of mehanical and electronic components is ssential to assure their reliability, it oes not necessarily predict the beavior of a major tactical unit in a iven environment. What was needed, ccording to John G. Bernard of Rayheon's Missile Systems Division, was a laboratory that could, so far as practical, subject complete missiles and whole units of ground support equipment to the environmental extremes expected in both transport and operation.

In setting up the lab over a 3-year period, many special problems arose which required custom designing of some of the facilities to meet unusual needs and applications. In some cases a joint effort on the part of Raytheon and the equipment manufacturers was necessary to produce the facilities required.

- **Physical extremes simulated**—All of the necessary equipment has been installed in a new 8000-sq.-ft. building. In addition to just about every known climatic and dynamic extreme, Raytheon feels its facility can provide simultaneously in-flight conditions such as high-frequency vibration, extreme low temperature, and high altitude.

The altitude-temperature-humidity chamber has a free test space 20 ft. x 8.5 ft. x 8 ft. high. It is capable, said Bernard, of simulated altitudes up to 100,000 feet, temperatures from −100°F

Breakdown of Recent Raytheon Hawk Contracts

Finalized—Sept. 30, 1960	(millions)
GSE & Test Instruments	$ 4.673
NATO Support	4.019
Military Assistance Program	1.873
Total	$10.565
Letter Contracts—Sept. 30, 1960	
Hawk Missiles	$16.900
GSE	8.056
Engineering Services	3.267
Field Maint. & Test Equipment	1.374
Total	$29.597
Total	$40.162

to +350°F, and relative humidity from 20% to 95% over a dry-bulb range of +35°F to +185°F.

This chamber has been specially constructed to accommodate a 5000-force-pound vibrator capable of operating under any of the conditions that the chamber can produce.

One of the smaller chambers provides wet and dry climatic extremes: simulated rainfall up to 4 inches per hour; or simulated solar radiation adjustable from 100 to 140 watts/sq. ft., with air at +125°F. Infrared, ultraviolet, and visible light lamps combine to expose *Hawk* equipment to the thermal and actinic effects of the sun in a desert location.

Another aspect of the desert climate is simulated in the sand and dust chamber. A complete 16-foot, 1300-pound *Hawk* missile can be subjected to blowing sand and dust at velocities up to 2300 ft./min., so that engineers can study the effects of dust penetration on the capabilities of the missile.

Salt air and spray exposure can be effected to simulate either a transport or an operating environment for any part of the *Hawk* system. Corrosion and electrolysis caused by this environment are investigated in the salt spray chamber, so that possible trouble spots can be eliminated before delivery of the equipment.

The largest chamber—for temperature-humidity studies—has internal dimensions of 25 ft. x 12 ft. x 15 ft. high. Major tactical units of the *Hawk* system (launchers, loaders, radars, etc.) can be operated here at temperatures from -100°F to +200°F and at any relative humidity from 20% to 95%.

Movable banks of infrared lamps designed to simulate solar heating add to the versatility of this chamber. Provision also has been made to accommodate the 5000-force-pound vibrator for dynamic testing under these different environments.

Automatic programing controls enable the climatic chambers to operate for extended periods with minimum supervision. Temperatures at various points on the equipment being tested are monitored by copper-constantan thermocouples connected to a multichannel recorder, which provides a permanent printed record for future reference. Other recorders provide permanent records of wet- and dry-bulb temperatures during humidity cycles.

• **Shakers and accelerators used**—Dynamic testing, said Bernard, is the other half of the environmental testing picture. It is extremely complex and the value of the information obtained depends greatly on the kind of facilities used. Just about any transport, operational, or in-flight vibration, acceleration, or shock likely to be experienced by the *Hawk* system can be reproduced in the Andover Environmental Laboratory.

A low-frequency vibrator simulates severe transport conditions for complete tactical units of the *Hawk* system. A 15,000-force-pound vibrator is capable of testing the *Hawk* missile or other large items. (As noted earlier, the 5000-force-pound vibrator can operate under the environments obtainable in the two largest chambers.)

A rotary accelerator 16 feet in diameter applies forces up to 100 g's to missile control packages and components. Set in a concrete pit for safety the accelerator has a 5-ft. cube free tes space at each end of the rotor and can accommodate test specimens weighing up to 500 pounds.

Three sizes of shock testers, capable of pulses up to 75 g's, complete the lis of dynamic testing facilities. Between them they can test components ranging from small parts up to 1500-lb. radar consoles.

A sequence of eight tests has evolved with experience in the Environmental Laboratory from which Raytheon engineers believe maximum information may be obtained:

–High temperature (or solar radiation)
–Low temperature
–Vibration
–Shock
–Humidity
–Acceleration
–Sand and dust
–Salt spray

With its ability to assure more positively the reliability of major assemblies and tactical units under a wide variety of climatic and dynamic conditions, this laboratory has contributed much to the effectiveness of the *Hawk* system.

Certainly, this belief by those who know the *Hawk* is borne out by its past high performance and its present widespread popularity. ⌘

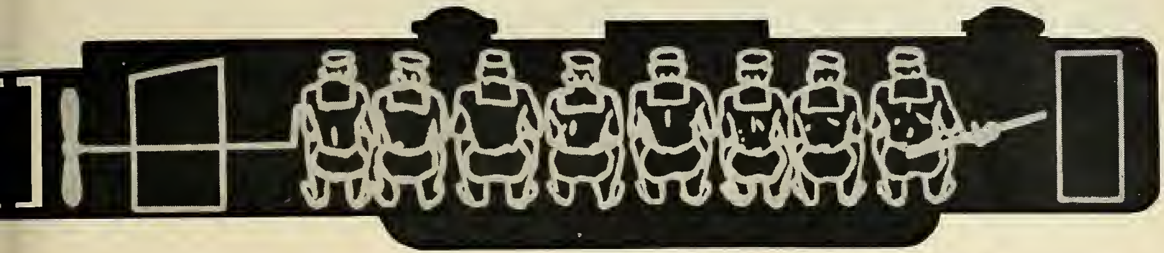
Grounded Bird

"FRUSTRATED FALCON"—a non-flying missile—is being used by the Air Force to train pilots and check performance of actual missiles and the launching aircraft's armament control. Instrumentation in the dummy Falcon records data on simulated or live-firing missions to pinpoint any erratic operation of the missiles or launching system.

The Challenge in ASW Engineering . . .

Submarine Ideal for Surprise Attack

An expert traces development of the sub from Revolution to the present; he notes that ASW progress has failed to keep up since WW II



CUTAWAY OF CONFEDERATE SUBMARINE Hunley, first sub to sink a ship in war, shows crew seated at crank shaft used to propel vessel. Hunley sank the USS Housatonic in 1864, but explosion also sank sub and drowned its crew—Navy Photo.

by Vice Adm. Harry Sanders USN (Ret.)*

FOR A COMPANY to participate effectively in the search for better ASW vehicles, weapons and equipment, it must have some understanding of the nature of the submarine and the environmental problems of undersea warfare. These two things determine tactics and techniques.

I have not listed strategy because strategy is usually a very simple thing —such as hitting the enemy hardest where he is weakest. Also, strategy is one of the few professions in which the amateurs know more than the professionals.

One of the main elements of tactics is mobility. There have been times when the principle has been overlooked.

Atlas and its fixed launching pads lack, as a system, mobility. The advent of *Polaris,* however, and the current plans to put *Minuteman* on flat cars are evidence that the importance of mobility is well recognized.

• **Ideal for surprise**—The main advantage of the submarine is its ability to operate with stealth—unseen and unheard. It is the ideal weapon for surprise attack. For this reason, the submarine has always been the weapon of the weaker naval power. When Robert Fulton persuaded Napoleon to test the Nautilus, it was only because Napoleon recognized what such a weapon could do to the British fleet. The Nautilus blew up a ship as a part of its tests but when it failed to sink any British vessels blockading the French coast, Napoleon cut off the funds.

The long reluctance of the British to have anything to do with the submarine was based upon their recognition of its power. They were afraid that if they built submarines other countries would and that would spell the end of British sea power. History has proved them right.

The easiest way to understand the capabilities and weaknesses of the modern submarine is to look at submarine warfare as it developed and then to try to evaluate the effects of the latest technological developments.

• **Frightened by bit**—The first submarine attack on a war ship was made during the Revolutionary War by a one-man submarine against a ship of the British fleet anchored off New York. This submarine, called the Turtle, looked like a fat pineapple. It was made of oak and iron bands. Its propeller was driven through gears and shafts by the one-man crew. Its weapon was a "mine," really a delayed-action time bomb, carried outside the hull.

First of Series

This is the first in a special series of articles intended to acquaint readers with the nature of the submarine threat, the ASW engineering problems involved, and the means or lack of means for solving them. Written by authorities in the ASW field, future articles will deal with environmental factors, sonar, hydrodynamics, oceanography and ASW weapons systems.

The bomb was supposed to be attached to the underwater body of the target by a brace and bit arrangement through the hull. The Turtle made a good submerged approach and the operator started to attach his mine. Unfortunately, the British ship he picked had a copper-sheathed bottom instead of a wooden bottom and he couldn't get the bit through. He therefore backed clear and made a submerged retreat.

Although he didn't succeed in blowing up a British ship, the result was a victory because the incident so frightened the British that they moved their fleet to a safer anchorage farther away.

• **First blood**—The first ship to be sunk by a submarine in war went down in 1864; the USS Housatonic was sunk in Charleston Harbor by the Confederate submarine Hunley. This craft, really a submersible designed to run awash, was propelled by eight men working on a crank shaft. The explosion also sank the Hunley, and her crew of nine drowned.

In World War I, the submarine, though much larger in size, was essentially a surface vessel which could

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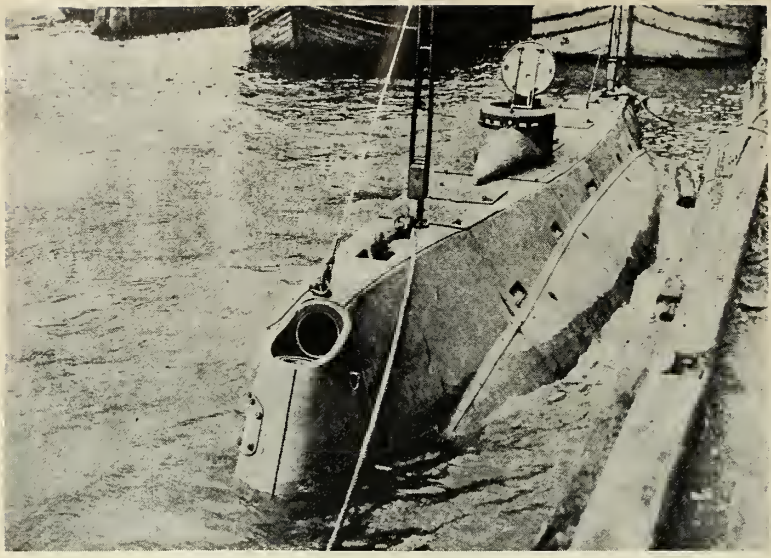
* *Admiral Sanders is Corporate Director, ASW Engineering, Chance Vought Aircraft, Inc., and a member of* MISSILES AND ROCKETS *Magazine's Editorial Board. Part II of this two-part series, a look into the future of submarines and antisubmarine warfare, will be published at a later date.*



USS HOLLAND, built by John Holland, was accepted by Navy in 1900. Note the tube in bow, from which an aerial dynamite torpedo was launched by compressed air.

submerge for short periods. It could not go very deep, only to about 200 feet. Much of its time had to be spent on the surface charging its storage batteries and looking for targets. It was very fragile. A hole in the hull caused by gunfire or ramming would make the submarine plunge to the bottom like a rock.

Submarine torpedoes were good enough. There was no torpedo control system in the modern sense, although the captain did have a sort of circular slide-rule. He estimated the target speed and its course. In the periscope was a telemeter scale which provided a rough range estimate. With these inputs, the circular slide rule worked out the angle of lead at which the torpedo should be fired.

Because of the crude state of antisubmarine measures, torpedoes could be fired at close range and, because the ships were sitting ducks, they were effective. The deck guns on submarines also accounted for heavy losses in Allied shipping.

- **Early defenses**—Antisubmarine warfare in those days consisted of gunfire and ramming. The depth charge and rudimentary hydrophones were then developed. Guns were put on merchant vessels, decoy ships such as the British "Q" ships were introduced, destroyers and small craft were fitted with hydrophones and depth charges, and the convoy system evolved.

Aircraft were equipped with bombs. Mine fields were laid, particularly the vast North Sea mine barrage; completed in 1918, it consisted of about 96,000 mines. This field accounted for some six submarines during the short remaining period of the war.

WORLD WAR II

By 1939 both the submarine, and antisubmarine measures, were greatly improved. The submarine had achieved higher surface speed and a marginal improvement in submerged cruising radius. The range of torpedoes was increased and torpedo control systems had been developed. Submarine communications were improved, permitting them to cooperate with aircraft and to assemble into wolf packs.

By the beginning of World War II, surface ship sonar was greatly improved. Magnetostriction devices had been developed commencing in 1929. The main antisubmarine developments came, however, during the war. The sonobuoy, which permitted aircraft to obtain indications of the sounds made by submerged submarines, was developed in 1941 by the Naval Research Laboratory. In 1943, the Naval Ordnance Laboratory developed the magnetic anomaly detector (MAD). This device was effectively used in the aircraft patrol of the Straits of Gibraltar.

Early in the war, submarine detecting radar was installed in aircraft. By 1942, German submarines were installing a radar search device which was effective against the long-wave radar (1½ meter) in British aircraft.

Microwave radar was then developed in this country. It was very effective in spotting submarines on the surface at night, and it forced the U-boats to remain submerged for much longer periods, thus greatly reducing their effectiveness.

It took the Germans several months to develop a search device which could pick up the microwave radar, becau they thought at first that the micr wave radar was an infrared devic Hitler, in a burst of exaggerated r crimination, said that airborne micr wave radar by itself spoiled his U-bo campaign.

- **Shifting tactics**—The tactics submarine warfare in World War had to change under the impact of the new devices. Until the convoy syste could be put in operation on the maj sea lanes, the German submarin went after independent shipping an they made a killing.

For example, after the Unite States got into the war, our lack surface escorts forced us to wait fro six to seven months before a coast convoy system could be set up. Durin this period German submarines san some 400 merchant vessels within 30 miles of the coasts of North and Sout America. Our lack of ASW aircra prevented us from taking effectiv measures from the air for sever months.

In March, 1941, Britain gave us 2 antisubmarine trawlers and 10 co vettes, all with crews. By May 1 1942, the first well organized convo sailed from Hampton Roads for Ke West. The system was then extende to New York and Halifax. The Ge mans, always anxious to attack whe we were weakest, then shifted thei major efforts to the Gulf of Mexic the Gulf of St. Lawrence and off th coast of Brazil.

- **Spotting subs**—One of the firs requisites of antisubmarine warfare i to know where the submarines are This was accomplished in World Wa II by the high-frequency radio direction finder net. Radio direction finder were installed on the eastern edge o the Atlantic from Jan Mayen to Afric and on the western side from Greenland to Brazil. When a German submarine transmitted a message, th whole net could be alerted in a matte of seconds.

Although the U-boats message were transmitted in very short bursts the HFDF net could be alerted an get cross bearings. The Navy Department and the British Admiralty wer thus able to transmit each day to al ships at sea the positions of Germa submarines.

Convoys were routed across th ocean on tracks designed to evade submarines. Thus the route of the convo looked like anything but the shortes distance between two points. This wa called "evasive routing."

- **Closing circles**—The main ide of the submarines was to find the convoys. Marshal Goering made some o his Focke-Wulf aircraft available t work with the U-boats and to direct them toward the convoys. The high surface speed of the U-boats and the lack of adequate Allied air cover in the early years of the war enabled the submarines to gang up and attack convoys spotted by the Focke-Wulfs.

The establishment of air bases for ASW patrol aircraft in Greenland, Iceland, Bermuda, Trinidad, and Brazil forced the submarines within the operating radii of the aircraft to stay under. Convoys were able to take advantage of this so that the Germans had to shift their submarines outside of these air patrol circles.

After Mr. Churchill dug up his 100-year-old treaty with Portugal, which permitted us to set up airfields in the Azores, the submarines had to move their operating areas to locations in mid-Atlantic not covered by shore-based aircraft. The U.S. Navy then (in 1943) moved hunter-killer groups, consisting of a jeep carrier and four or five destroyers, to attack the submarine concentrations in these mid-ocean areas.

By this time we had also installed in our destroyers a good surface search radar. The submarines, until this time, could operate on the surface at night, and by their superior surface speed (17 knots for the submarines against 8 to 10 knots for merchant convoys and 12 to 15 knots for troop convoys) overtake the convoys and attack them from the quarter or rear.

Imagine the surprise of Admiral Doenitz when one night in 1943 two or three U-boats suddenly were sunk in the dark when they made the usual attack on the surface against a convoy. It did not take him long to guess that, in addition to the radar-controlled 5-in. guns in our destroyers, we now had a good surface search radar. Thereafter, the surfaced U-boats could not approach any convoy.

• **Other developments**—The British were very alert to the advantages of aircraft in ASW. Their Coastal Command aircraft were put under Navy control early in the war, and they used jeep carriers accompanied by destroyers to operate against submarines independently. They were also aware of the need for aircraft in the vicinity of the convoys.

The Germans developed torpedoes with acoustic homing heads; by the summer of 1943 they were distributed to the U-boats. U.S. destroyers then began to outfit themselves with torpedo deflecting gear. This contraption consisted of a small wooden raft with metal pipes towed astern. The metal pipes vibrated in the water, and the homing head of the torpedo was supposed to seek the raft instead of the destroyer's propellers.

One of the great mistakes the Germans made was their failure to attack our escorts rather than the merchant ships in the convoy. If they could have equipped their submarines with acoustic torpedoes earlier in the war and if they had then concentrated upon the destruction of escorts, the battle of the Atlantic might have taken a different turn. In December, 1943, I asked a German submarine commander why he had not fired his acoustic torpedoes at my ships. He replied that he would have liked to, but that the torpedo tube shutters had been jammed by depth charge explosions and he could not, therefore, open the torpedo tube doors.

This incident is typical of submarine warfare. Depth charge explosions normally do not sink but only damage a submarine. Either the diving planes or the rudder for their operating gear is jammed, or the hull begins to leak. In either case, the submarine is forced to surface. When that happens, the destroyer's guns make short work of the surfaced submarine.

• **Snorkel arrives late**—The growing antisubmarine air offensive, due particularly to the great increase in the number of ASW aircraft and to the employment of microwave radar, forced the Germans to design and install snorkels in their submarines. The snorkel was a great invention because it largely nullified the capabilities of aircraft and permitted submarines to cruise submerged at speeds of nearly 18 knots and also to charge their storage batteries submerged.

The snorkel, however, was introduced in the later stages of the war when our antisubmarine effort was very powerful. This device, like the acoustic torpedo, if introduced earlier would have changed the course of the submarine campaign. Winston Churchill remarked that the snorkel in Soviet hands was one of the hazards of the future. We can only guess what his remarks would have been if he could have foreseen the nuclear submarine.

Since World War II, the development of the submarine has proceeded at a fantastically rapid pace. Nuclear propulsion has revolutionized the submarine—and perhaps naval warfare itself. Ballistic missiles, particularly the long-range *Polaris* type, have given the submarine a tremendous capability for deterrence and retaliation.

The concurrent progress in ASW has been comparatively very small indeed. Although the U.S. Navy, the American scientific community and industry have made great efforts, the problems that face us are the most difficult in the whole area of defense. ⌘

(Part I of a two-part series)

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U.S. Firms Nail Down European Markets

Prospective $2 billion annual propellant sales stir purchases and mergers with European manufacturers

by S. David Pursglove

U.S. PROPELLANT firms are moving into Europe to cash in on a more than $2 billion per year propellant market now forming in NATO countries and other Western European nations.

Some American chemical and propulsion system companies have bought European firms, some have merged, others have created European divisions for production and marketing. Some simply have established contacts to exchange information now, to help sell later.

No matter what form the action, it has been prompted in each case by bold handwriting on these three walls:

–The new tariff-oriented trade groups are here to stay.

–The U.S. is insisting more strongly that propellants be supplied locally.

–European governments are starting to put more money into propellants R&D.

European tariffs have traditionally favored the Continent's and England's strong chemical industries. This has been especially true in several of the nations important to the missile business: Belgium, England, France, and Italy. Acceptance of the European Economic Community (Common Market, or Inner Six) and the European Free Trade Association (Outer Seven) soon will make American firms' jobs in Europe harder. It will be almost impossible for U.S. chemical companies to compete in Europe without manufacturing there, or without selling through favored European affiliates. This is the consensus of American chemical company representatives, government trade authorities, and even the Defense Department officials who may be unwillingly abetting the situation.

• Why worry about Europe—Is there really a propellant market in Europe? The total Western European defense budget for the next twelve months is $12 billion. Authorities believe about $700 million will be spent by these countries on propellants. Up to that same amount will be spent for propellants by U.S. forces in Europe. This is a significant, but not large, market. However, if the U.S. does not pull its missiles back into a "Fortress America," and if Europe's own plans are mostly fulfilled, the European propellant market in less than three years will far exceed $2 billion per year.

PAUL M. TERLIZZI, of Stauffer Chemical Co., which is busy in Europe.

Much of this money will be American. However, it will be U.S. money spent in Europe to buy native propellants that do not have to be shipped. The Pentagon is urging more local purchasing of propellants (in spite of this month's token reversal of the off-shore procurement policy in other areas). Defense officials want an on-hand propellant capability for each new missile base that we build, or that we promote through NATO.

The list of missiles already in Europe, and which must be supplied with propellants, is impressive:

Thor (LOX and RP)
Mace (Solids and JP)
Jupiter (LOX and RP)
Matador (Solids and JP)
Corporal (Nitric acid and analine
Honest John (solids)
Nike-Hercules (solids)

Close observers of the Europea military rocket scene say don't discoun the solid fuels in this list. Some of thes missiles will be replaced by those usin storable liquids, some older ones may b fitted with "fresh" engines, and finall they point out that it may be economical to ship missiles from the U.S., an install solid motors cast in Europe. Al chemical firms are looking to tw moves that definitely are in the cards moves that will create an even bigge market directly in chemicals: (1) A switch to storable liquids, (2) use o high energy propellants. They particularly look forward to *Hawk*-typ programs involving missiles using hig energy propellants that must be produced locally. The *Hawk* program is fo $500 million, with about $100 millio going into low-cost propellants. In planning for a major European marke propellants firms and other chemica companies envisage larger program calling for more expensive propellants

• Private spending to go up—Th requirement that propellants be purchased locally will be enforced eve more rigidly with the arrival of late generation missiles requiring highe energy or otherwise more sophisticate propellants. This leads to the third reason that nearly every U.S. chemica firm is rushing people to Europe:

Observers report that Europea governments are about to increase many-fold, their spending on propellants R&D in private firms. Until now the little government money spent fo propellants research has gone to government installations and universit laboratories. Suddenly Europe finds itself called upon to produce great quantities of propellants, and to gear-up fo propellants that haven't even been full investigated yet. The governments ar turning with open pocketbooks to private industry to meet the challenge

Much money is being diverted from university basic research to industrial applied research and development. (However, American contracts and grants—mostly through ARPA, ARDC and the Navy—are filling what could become a void in basic research.)

U.S. firms stand to benefit from this new impetus by more than just production contracts executed through affiliates. Unless all past experience suddenly loses meaning, the heavy pressure on propellant firms will mean important new technical developments in Europe. These will be developments that can be applied in the U.S. by affiliates of European patent holders.

• **Joining in**—Most U.S. propulsion firms and chemical companies interested in propellants are climbing on the European bandwagon. Some are tiptoeing, cautiously feeling their way; some are jumping on enthusiastically and noisily. Typical of a mid-way approach are the moves being made by Stauffer Chemical Company.

Paul M. Terlizzi, asst. to the vice pres. (research), says Stauffer believes it is in about the same planning state as are many other companies. Stauffer is developing European contacts in industrial chemistry on one hand, and is building up a rocket propellant research expertise and production capability on the other hand. When the budding European market blooms, the company need only bring the two areas together in order to bring in its share.

Terlizzi is a research representative in Washington; however, much of his effort is in working with Stauffer's newly created International Division to determine the pros and cons of rocketry ventures in Europe. His Washington headquarters keeps him in close contact with Federal policy makers and spenders, NATO officials, and European embassies and trade missions.

The International Division under general manager F. W. MacMullen opened its Geneva office last year to handle Stauffer's European industrial accounts—boron and sulfur products, and medicinal chemicals—and to keep in touch with European rocket business developments. In this latter area, the Geneva office's major interest is in boron compounds.

• **High energy fuels**—Boron, fluorine, and lithium are the important conversation topics today in Europe. The newer U.S. missiles, and probably some NATO aircraft, will call for high energy fuels. Boron promises to provide the first economical, truly high energy fuels practical for wide use. However, Europe has only two important sources of boron compounds: Larderello, of Pisa, and Suddeutsche Chemische Werke.

SCW, wholly owned by Stauffer, produces refined borax, metallic borates, and boron fluorides from crude borates shipped by Stauffer's U.S. facilities. Production is for industrial accounts, but the company's experience on the scene and its marketing organization, besides its production facilities, are available for any Stauffer move into the European rocketry market. The International Division already has developed important contacts among R&D firms and universities during work on H-E fuels, and has supplied some of them with boron compounds and technical assistance.

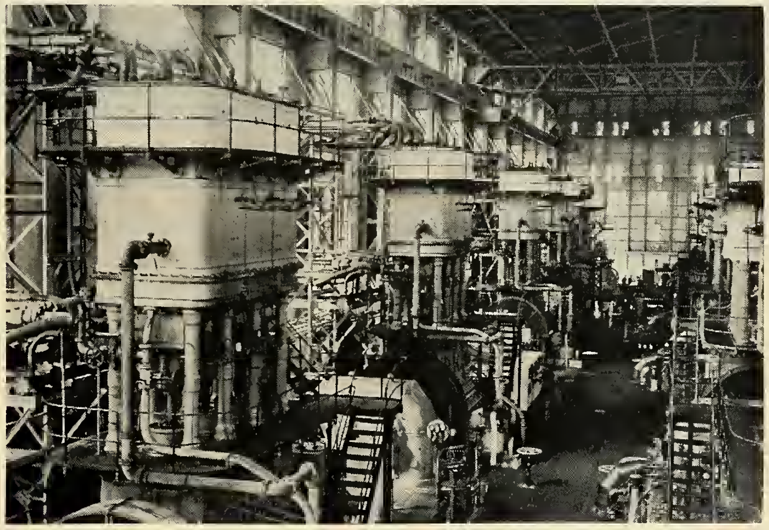
Like most chemical companies, Stauffer found propellants old hat, but propulsion something new. An early move to develop expertise in propulsion was the formation with Aerojet-General of the Stauffer-Aerojet Chemical Company to investigate H-E fuels under an Air Force contract. This is one of the few organizations not hurt by the Defense Department's cut-back in the high energy fuels program last year. The company has put on stream a major pilot plant to prove-out a new process for low cost manufacture of classified H-E fuels intermediates.

• **New contacts open**—One of Stauffer's big moves last year was to form Kali-Chemie-Stauffer G.m.b.H. jointly with Kali-Chemie, A.G., of Hanover. The firm will produce insoluble sulfur at a plant now under construction in Nienburg, W. Germany. The sulfur itself may find a rocketry market, but more important to Stauffer's planning are contacts and marketing organization soon to be available.

Such contacts are more important than they seem. Recently, Callery Chemical Company announced a program of boron chemistry information exchange with one of the world's largest chemical firms, Imperial Chemical Industries (ICI), England. A Callery official points out that traditionally information exchange programs are forerunners to cross-licensing agreements, and often lead to marketing relationships. He cannot say whether this is in the cards for the Callery-ICI venture, but the word has spread that technical representatives of the two companies are already enthusiastic about certain mutual interests that involve military as well as industrial boron applications.

Several top Callery officials recently returned from a European survey fired with prospects in military rocket fuel areas. So far, Callery believes it will be unnecessary to set up an overseas organization to market propellants in Europe. The Firm is jointly owned by Gulf Oil and Mine Safety Appliances. Both have well-established European operations available to Callery.

Besides such liquid oxygen suppliers as Linde and Air Products, who are doing well in Europe, some other U.S. chemical firms that are expanding in propellants and European interests simultaneously are Esso Research and Engineering, American Cyanamid, Dow Chemical, Food Machinery & Chemical, and several divisions of Union Carbide. Some of their relationships with the European rocket and propellants business will be discussed later in M/R in a roundup of what European and South American companies and their governments are doing and plan to do in propellants. ⌘



LARGEST CHEMICAL FACTORY in the British Commonwealth is Imperial Chemical Industries, Ltd., plant at Billingham. ICI is trading boron data with Callery.

HIGH-PRESSURE triplex pump units used in NASA's automatic cleaning of big Saturn tanks

Saturn Tanks Cleaned Automatically

HUNTSVILLE, ALA.—Engineers here have developed a pressure-driven automatic method of cleaning the huge *Saturn* propellant tanks after use.

The automatic method promises to reduce the trouble, effort and expense formerly involved in hand-cleaning tank interiors after they leave the fabrication shop.

Frederick J. Beyerle of the Marshall Space Flight Center, National Aeronautics and Space Administration, says center bulkheads in the tanks prevented the use of pressure cleaning of *Redstone* and *Jupiter* missiles.

Cleaning of both fuel and LOX tanks is necessary, he noted. If numerous particles of large micron size should gain entry into either tank, orifices downstream might be clogged, causing a valve malfunction that could lead to the loss of a multimillion-dollar booster. In the LOX systems, all hydrocarbons or organic contamination must be removed. As these are LOX impact sensitive, an excessive buildup could cause fire or an explosion.

• **Joint development**—Dow industrial service, a division of Dow Chemical Co., and personnel of the NASA group, formerly with the Army Ballistic Missile Agency, developed the cleaning process jointly. Equipment consists of a high pressure triplex pump, a deionizer, high and low-pressure micronite filters, a high-pressure heat exchanger, centrifugal pumps, stainless steel storage tanks, reel and hose actuator, high-pressure jet-spray devices and interconnectors and lines. The stainless steel parts are lined and gasketed with Teflon where applicable.

The outer *Saturn* tanks, with diameter of 70 in. and length of 60 ft., are cleaned in a vertical position by spraying detergent water at a pump pressure of 2000± 500 psi at a rate of 60 to 80 gal./min. from a head fed by a flexible hose.

Rotation on the vertical axis assures complete coverage of the interior. The spray is centered by observing the vibration resonance. The head, rotated at 5 to 6 rpm, has a travel speed of 3 to 4 ft./min. The hose reel is operated hydraulically.

The detergent solution is at a temperature of 125° to 130°F, which aids in removing some organic contaminants and later in drying the tank. After the detergent spray is completed, the same operation, using the same pressure ratings, flow rates, spray head revolutions and travel speeds, is carried out with demineralized water.

• **Air dried**—Drying is accomplished with missile grade air or nitrogen of less than 3ppm hydrocarbon until an anhydrous condition of 0 to 5% shows on the dew-point indicator.

LOX containers are purged with trichlorethylene at ambient temperature and a pressure of 100 psi. A 3-ft. double-armed umbrella jet spray device spins at 4 rpm and moves 3 to 5 ft./min. to remove organic contamination. Then the container is dried with missile grade air or nitrogen.

On the discharge side of the tank the effluent demineralized water is sampled on a continuous flow basis to determine particle sizes. NASA specifications allow 5 particles between 175 and 700 microns, one between 700 and 2500 microns and none above 2500 microns per square foot of surface area.

The effluent trichloroethylene is also sampled on a continuous flow basis during the one-cycle operation to determine hydrocarbon levels. Maximum hydrocarbon concentration allowed is .005 gram per 500 ml of solvent per square foot of surface area.

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U.S. Hikes Funding for Life Research

Seven agencies tell ARS meeting they'll support studies ranging from radiation to extraterrestrial life

by Heather M. David

DAYTON—As many as seven agencies now offer funds for life sciences research applicable to space, in contrast to the two or three of a few years ago.

Among the National Institutes of Health, the Air Force, the Army, Atomic Energy Commission, National Aeronautics and Space Administration, Office of Naval Research and the Office of Science in the Department of Defense, there is a huge potential source of funding for both practical aspects of space medicine and basic research on the laboratory level.

In the highlight of the first American Rocket Society meeting on human factors and bioastronautics, seven representatives from government grant-giving or contracting agencies told of potential support in their agencies.

• **National Institutes of Health**—The giant of the grant givers, NIH covers all medical and biological fields and has a yearly budget of several hundred millions. Last year just under half its applications were granted.

Dr. Ernest M. Allen pointed out that as spaceflight becomes more and more a public concern, NIH will award more money in related health research.

Working entirely on the grant system, money is given in lump sums with no restriction on how it's spent to ccomplish the research purpose. The nstitutes are: Cancer, Heart, Allergy nd Infectious Diseases, Arthritis and Metabolic Diseases, Dental Research, Mental Health, Neurological and Diseases.

Possibly most interesting to the pace medicine field is NIH's Division f General Medical Sciences, which overs any program not specifically oncerned with the seven Institutes.

• **Atomic Energy Commission**—The Division of Biology and Medicine offers four areas in which a scientist interested in working on radiation hazards could find support.

Dr. Max R. Zelle outlined these as: 1) effects of radiation on biological systems—constituting 37% of the division's total program; 2) problems arising from AEC operations (accidental exposures etc.)—35%; 3) radiation protection—6%, and 4) exploitation of radiation for beneficial aspects —22%.

The AEC division does about two-thirds of its work in its own labs, but has some 600 current outside contracts. Although AEC works on the contract system, Dr. Zelle pointed out that 90% of its contracts are unsolicited and applications can be made at any time. Funds are relatively unencumbered, he noted.

•**NASA**—The National Aeronautics and Space Administration offers both grants and contracts in the full gamut of research related to the human or animal system in space, including the search for extraterrestrial life.

Awards are made in the three divisions of the Life Sciences Office: space biology (molecular biology and cellular environmental physiology and extraterrestrial life), space medical and behaviorial sciences (neurophysiology and psychology, metabolism and nutrition and cardiovascular and respiratory physiology), and flight medicine and biology (experiments in the space environment and biotechnology).

Dr. Freeman H. Quimby called for both instrumentation and experiments to be carried on space probes and laboratory studies. One prime area of concern in the space medicine and behaviorial sciences area is to find protection beyond conventional means for radiation.

Proposals are evaluated by the NASA staff and examined by the NASA Life Sciences advisory committee for each field. (M/R, Oct. 10, p. 32).

• **Army**—Although the Army has no bioastronautics program as such, it supports research which also might have spaceflight application, according to Lt. Col. Richard R. Taylor.

Contracting is done exclusively by negotiation and is generally unsolicited. The Army mostly deals with non-profit organizations for basic research and with universities.

Some of the current space-applicable studies supported by the Office of the Surgeon General are: chemical protection against radiation, effects of stress on soldiers, effects of noise in relation to performance, and the medical aspects of nutrition, such as algae studies.

• **Office of Naval Research**—The Navy also offers aid to programs in its field which also might have space application, such as some aspects of the submarine program. Studies of toxicology, stress physiology and hydrobiology could have dual application.

ONR's program comes under the Biological and Physiological Sciences Division. Research programs are, of course, unsolicited.

An interesting point brought up by Dr. Sidney Galler was that ONR does not advocate "short forms" in proposals. He noted that ONR's reason for granting funds for basic research might not be because of the scientist's objective, but because ONR wanted research in the field for different reasons. The details which might attract ONR might not be mentioned on a brief form and the proposer would not get the contract.

• **Air Force**—As in NASA, both grants for basic research and contracts for specific programs are awarded.

Most of the Air Force's space medicine and life sciences programs are administered by the Air Research and Development Command. Contracts are awarded at the division and center level, such as at AFMDC for the School of Aviation Medicine, or WADD for the Aerospace Medical Laboratory.

Basic research related to the field is handled in both grants and contracts from AF Office of Scientific Research, Washington, D.C. Industry, as well as non-profit organizations, can receive OSR support.

Air Force interest is broken down into four general areas: biologistics, support of man in his natural environment; biomechanics, man's relation to operationally induced environment; radiobiology, and human performance.

Bionics has been treated as one of these areas, but the Air Force is considering separating it as a fifth area, according to Dr. A. W. Hetherington, Technical Director of the Directorate of Life Sciences, ARDC.

Dr. Hetherington suggested that unsolicted proposals to the Air Force be drawn up in short form, eliminating considerable expense. He answered the complaint from a small company representative that unsolicited proposals were sometimes taken and opened for bids—then given to another contractor.

• **Department of Defense**—Col. John M. Talbot reported that although the Secretary of Defense Office of Science relies on the three military services for action in the space area, there could be some dovetailing fields of interest with DOD.

The Defense Atomic Support Agency, for instance, might entertain proposals on radiobiological effects, especially if they were not particularly appropriate to any single service.

There are still some dual areas in the Advanced Research Projects Agency, although it is no longer concerned directly with space.

Other fields covered in the meeting were bioinstrumentation, anthropometrics, bionics and human factors.

Unfortunately the ARS Conference received only sparse attendance. Only about 125 representatives attended the three-day session, although the delegates ranged from university people to industry.

ARS officials blamed the poor attendance on the fact that a huge WADD-sponsored Bionics Symposium had been held in Dayton only the month before, and that programs had not been distributed early enough.

The ARS Human Factors and Bioastronautics Committee is considering future joint meetings with the Aerospace Medical Association and the Human Factors Society of America. ⌘

Mice to be Bred after Trip into Van Allen Belts

Medical and nuclear authorities are closely scrutinizing some 600 lbs. of experiments—including three black mice—which made a 650-mile high trip into the Van Allen belts.

The heaviest payload ever to be recovered by the U.S., the mice and over ten other experiments rode in a General Electric RVX-2A nose cone on an Air Force *Atlas* missile. The trip took them 5000 miles down the Atlantic Missile Range, where they were recovered several hours after impact.

Within weeks results from some of the experiments will be known. The mice so far have shown no ill effects and no premature graying from their exposure to radiation. The male-Moe-will be mated with either of the females Amie or Sally to study genetic effects.

Dr. Hans Clamann, Chief of the Department of Space Medicine for the School of Aviation medicine, said it would take about a year to get complete results on the mice—the first animals to be recovered from the Van Allen belt. Some preliminary ideas can be obtained within a month, he indicated.

Physiological data telemetered to Cape Canaveral for the first 17-minutes of the half-hour journey showed normal heart beat, temperature and muscular movement, except for a brief moment at launch. Medical experts attribute this to fright at the noise and g-forces of acceleration. Data was transmitted from signals emanating from a transistorized meter weighing a quarter of a pound. Only one of the females wore the tiny bioinstrumentation package.

• **Not purpose of trip**—Although publicly the most popular members of the flight, the mice actually rode the *Atlas* on a space-available basis. Primary objective was to test a new ablative nose cone material developed by General Electric, called GE Series 100. The recovery vehicle is undergoing evaluation together with the telemetry data.

Other experiments in the 12-foot nose cone included two space power systems, radio measurements, and a number of radiation measuring devices. GE was systems coordinator for AFBMD. Experiments were:

–An experiment to help crack the telemetry blackout occuring when a space vehicle re-enters the atmosphere. These radio measurements were provided by the Wright Air Development Division, ARDC, Ohio State University and General Electric.

–An experimental GE fuel cell tested particularly for its behavior during weightlessness. A closed-cycle device, it operates by oxidizing hydrogen and oxygen to produce water, then regenerating itself by electrolysis of the water back to hydrogen and oxygen.

–A magnetohydrodynamic generator developed by Space Technology Labs.

–An attempt to discover the rate which radiations in the Van Allen belt would enter the human skin. Air Force special Weapons Center provided this experiment, results of which will be correlated with the SAM mouse biopack data.

–AnSTL and University of California Lawrence Radiation Lab nuclea emulsion package, designed to measure the flux and energy distribution of protons and electrons in the belt.

–Air Force Cambridge Researc Center's highly-sensitive cosmic ra measuring device, consisting of a emulsion package and monitor de signed to measure trapped and pri mary cosmic radiation which migh have escaped previous detection.

–Emulsions provided by NASA t measure flux, composition and energ distribution spectra of particles in th lower edge of the inner Van Alle Belt. The University of Minnesota, Uni versity of Rochester, Naval Researc Laboratory and NASA Goddard Spac Flight Center cooperated on thi project.

–A proton-measuring device includ ing a variety of emulsion packages t provide more knowledge about th sharp changes in radioactive energ characteristics in the belts. The L Alamos Scientific Laboratory designe this experiment.

–Ultraviolet-sensitive proton coun ers hoped to shed light on effects solar radiation on the upper atmo phere. Wright Air Development Div sion, and Armour Research Foundatio combined on this device.

–An experiment developed WADD and Ohio State University measure the reflection of radio a radar signals and the undesirable tuning of antennas caused by ioniz tion.

est we 'run out of gas' . . .

A Call for Intellectual Innovations

by Lt. Col Francis X. Kane, USAF*

AMERICA'S TECHNOLOGICAL rive to outrace Russia today is facing ie danger of running low on gas.

The gas of technology—the fuel that iakes possible the so-called techno- gical breakthroughs of our era—is rawn from our civilization's pool of asic scientific knowledge.

It is the current rapid emptying of iat pool which confronts us.

A space system which can function iattended and achieve performance of ie reliability such as some scientists ave proposed deserves the description f "remarkable" and "ingenious." Simi- rly, the miniaturization of a computer in appear as nothing short of fantastic.

Yet, almost without exception, such chievements are the products of past itellectual advances. They are not truly inovations; they are extensions. Op- mism for the future founded on such n approach is an empirical extrapola- on which may not be well founded. he achievements of the future will be- ome a reality only if there are signifi- ant intellectual innovations today.

Our terminology indicates that the elationship between intellectual ad- ances and technical progress is not ompletely understood.

For example, when the U.S.S.R. aunched its first *Sputnik* the achieve- ient was decried by some as being a brute force" solution. Our satellites are eemed to be somehow superior be- ause the systems are more refined and maller. But our follow-on projects de- end directly on a "brute force" solution n propulsion. Bigger payloads in orbit vill be possible by larger propulsion ackages, once again an extension of he past and not truly a "breakthrough," lthough the term will surely be used in escribing coming advances.

• **Leaping ahead**—The missing ele- ient in our approach is the realization iat the extensions we see today result rom intellectual "breakthroughs" of ie past. Empirically, the course of the iture depends on whether or not "quantum leaps" in ideas are occurring now and will continue to occur.

The question of time is a basic factor in military considerations. There is periodic re-examination of the time-span from drawing board to inventory, that is the elapsed time between the initiation of the development of a weapon and its eventual use by the operating forces. An even more basic consideration is the total time-span from conception of a new idea to its acceptance and from acceptance to application to a military problem.

Let us examine some historical experience in this field.

Einstein freely acknowledged his debt to several of his scientific predecessors. Maxwell announced his findings on electromagnetism in 1864. Mach first proposed his concepts of the limits of the classical laws of physics in 1883. Einstein published his first paper on the Theory of Special Relativity in 1905.

Thus the first phase of the process, the appearance of a radically new approach to physics, covered some 30 years. The potential of Einstein's theory was recognized almost immediately, but the debate on its validity lasted another 20 years. Bohr and de Broglie attest the importance of the debate at the Solvay Conference in 1927 in the process of acceptance. The intellectual stimulus which Einstein provided and the eventual application of the resulting new knowledge to military use followed by another 20 years, a total of some 70 years.

And even then, this application would not have occurred except for the circumstances of the war and probably not at all except for Einstein's direct appeal to President Roosevelt. The appeal carried weight mainly because of the stature of Einstein which followed from the acceptance of his ideas by the scientific community.

Another example is the modern computer. Boole's *Laws of Thought* appeared in 1854. The *Principia Mathematica* of Whitehead and Russell came some 60 years later (1910-1913). The marriage of mathematics and electronics occurred only after World War II, a period of another 30 years. The refinement of the basic application has taken another 10 years. So that in this instance, the total period covers a century.

• **Conception to drawing board**—Thus, to the military man, the significant time period is not from drawing board to inventory. This is a fraction of the total process even though we consider it a breakthrough if the interval is reduced from 8 to 5 years. The really significant time period is from the intellectual breakthrough to the drawing board.

Here we are talking in terms of possibly two generations of scientists or more. We are dealing with two processes, each of which spans the life of a group of scientists. One period covers the development and spread of a new concept; the other period covers the acceptance and initial application of the concept.

From another point of view, we could say that the scientists of today are restricting themselves too much to the process of deduction. They seek ways of applying general principles to specific problems. A great search is on in the intellectual residue of the past in order to achieve the technical breakthroughs of the present.

In part, this phenomenon results directly from the contemporary environment. The military man is pressing the scientist to conduct such a search because of the great danger to our national security and the seemingly insurmountable problems which come from meeting the threat. Under this stimulus the scientist is "pinned down," fixed on a given task of applying existing knowledge and proven ideas to specific problems. General problems, or lines of investigation which will come to fruition in the future as well as ideas which are radically new are of lower priority.

While we postulate a continuing and growing threat to our security, we are following a course of action which depends on intellectual achievements of the past. Our unformed assumption here is that a series of limited technical advances will give us a total of achievements sufficient for our security. Whereas, an intellectual breakthrough could lead to a major advance which would insure our technical lead.

The Air Force recognizes the vital role of basic research. This is well illustrated by the growth of the funding of our programs. We have identified the need for new knowledge in various areas, such as materials and propulsion. We are pressing chemists and other

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* *Lt. Col. Francis X. Kane is a spe- al assistant to the Air Force Deputy hief of Staff/Development. The opin- ns expressed in this article are his vn and do not necessarily represent e official thinking of the Air Force or epartment of Defense.*

we wait for state of the art . . .

scientists to create new ideas which will have an impact similar to those which revolutionized the science of physics. All these endeavors to break with an "archeological" approach to security are steps in the right direction.

In approaching this task there is one unknown which we will always face. It is impossible to forecast the nature and content of creative human action. Bergson once said that if such vision were possible, he would be busy producing such advances. But having identified the need and having indicated the areas which scientists should investigate, we can anticipate that innovations will occur.

Here we should keep clearly in mind that the breakthroughs we seek are of the type achieved in theoretical physics. Advances, such as the two examples already cited, resulted from a questioning attitude toward accepted "classical laws." They arose not from applying ideas of the past, but rather from departing from the past to make a new future.

In discussing archeology or innovation, we are dealing with technological strategies. It is generally recognized that there are two basic strategies for using technology to meet military needs.

Advances in weapon systems and capabilities may be tied to the "state of the art." Under this strategy the man in uniform waits for the scientist to produce and prove new theories and for the engineer to make them practical realities.

The advantage of this strategy is that "proven" systems or components may be introduced into the inventory at forecast times. It is thus a "low risk" approach. One of the main concerns for the military man is that technological surprise may occur. This strategy is valid as long as rates of advance are of the same order of magnitude and as long as potential enemies do not make specific applications which result in major increases in military capabilities.

- **Invention by timetable**—Under the other strategy the military man tries to determine the rate of advance by stating requirements for the scientist to meet. The major objection here is that the scientist must "invent on schedule." As we have seen, it has been impossible to forecast when specific advances will occur. Thus this strategy is a "high risk" approach which may lead to high levels of research and development spending and to disruption of future capabilities if systems or components do not materialize at forecast times. However, this approach can result in major advances in capabilities.

These two strategies need not be applied uniformly throughout a research and development program. They can be applied to parts of the program or to specific projects within the program. Also, the strategy for a specific project can be varied depending on the circumstances and the need.

This can be seen by comparing the Russian missile program with ours. The Soviets placed their emphasis on propulsion presumably because the state of their art in nuclear weaponry was more primitive. Thus their strategy was to stress requirements for propulsion. Our strategy was to wait for technology to give us a major advance in nuclear weaponry. When this advance was forecast to be in the offing, we started to place requirements on other components of missile systems, such as guidance and propulsion.

- **ANP frustration**—One of the most striking examples of varying strategies is the program to develop a nuclear powered aircraft. This is typical of the technological strategy of letting "state of the art" determine rate of advance. At times there have been attempts to find backing for military requirements so as to put more emphasis on the program. The outstanding attempts were the agitation for a supersonic airplane and the CAMAL concept —a nuclear-powered airborne missile launcher. Both of these came to nought and we are continuing to let technology determine the time when the first flight will occur and usable military systems will appear.

When we examine the basic approach to nuclear powered flight we see that it is a form of microminiaturization. We have spent 15 years and nearly a billion dollars in trying to reduce the Soldiers' Field atomic pile to jet engines proportions. Our effort has concentrated on refining reactor technology.

The military interest in nuclear powered flight comes from the attraction of great endurance. Freeing the aircraft from the limits imposed by the propulsion system would give us strategic and tactical possibilities which have long been sought. But after such a prolonged effort and faced with the prospects that a feasible system is still some years away, we may well ask if we are on the right technological path. Perhaps we have asked the scientists the wrong question.

- **Single approach**—The problem is to use nuclear energy for propulsion. This is not necessarily the same as developing a reactor for the propulsion system. The scientist could properly ask "what other technical approach possible?" At the present time th answer is "none." This is really th heart of the problem of nuclear pow ered flight. And, as long as we have a archeological viewpoint, the answer wi be the same.

We need an "intellectual breal through" in nuclear theory. It has no been some 20 years since the theori of Bohr, Fermi, and others were prove to be a practical system for the con trolled release of nuclear energy. O the basis of historical experience a ne theory should be forming in the scien tific community. The possibility of suc an occurrence should be enhanced b our concentrated effort in nuclear tecl nology. The emphasis which we hav put on this part of our scientific effo has given us a broad foundation o which a new synthesis may be built. Bu as already described, the time of th appearance and the content of such a advance depends on outstanding in dividuals in the right circumstances.

As we have seen, the appearanc of a new theory is far from the realit of meeting military needs. If it tak two generations of scientists to go fro theory to application, we will be in th next century before today's ideas w result in a nuclear powered aircraf This span of time reflects historical e perience. It will be a fixed period f the future only if we do not learn fro the past.

- **Military urgency**—There a marked dissimilarities between the pa and present which result from tl urgency of military needs. The A Force has a basic research progra measured by its funding (some $42 m lion a year and scheduled to double the next few years). These funds a concentrated on a search for new idea

Also, while we cannot anticipa specific creative ideas, there are tv areas in which we can assist "intelle tual breakthroughs." These are reco nition and acceptance. The time-sp of the two phases can be greatly r duced over previous experience. Co munication of ideas, both through t forum and translation, is much mo rapid than in the past. Thus, concei ably, the problem of recognition c be simplified.

The same is true for acceptan which follows only after debate, evalu tion and verification.

In the field of military research a development, various practical measu have been proposed. They cen around the approach of "breadboa testing" of new concepts as they a recognized. This approach would me an expanded and thus more costly a plied research program. Hardware wo

(continued on page 49)

Orbits through space

he space-flight paths diagrammed above represent a closed elliptical orbit, a arabolic orbit, and, on the outside, an open, hyperbolic orbit characteristic f the start of an interplanetary flight.

Orbital flight mechanics is one of the many areas of advanced investigation at oeing. The staff of the Boeing Scientific Research Laboratories, for example, arries out basic research in such fields as energy conversion, hypersonics, agneto-hydrodynamics and plasma physics.

Other Boeing scientists and engineers are working toward the advancement f supersonic flight, propulsion systems, gas turbine engines, commercial and ilitary aircraft, vertical and short take-off and landing aircraft.

Professional-Level Openings

The wide scope of Boeing programs in all areas of manned and unmanned flight, from theoretical research to advanced precision fabrication, offers careers of unusual interest to professional specialists in engineering and scientific fields, as well as in other-than-engineering areas. Drop a note, mentioning degrees and major, to Mr. John C. Sanders, Boeing Airplane Company, P. O. Box 3822 - MIJ, Seattle 24, Washington.

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Cover Story

Army Proves Out Its Drone Control System

Rugged system developed by Ford Instrument rides herd on surveillance craft from launch to recovery

FT. HUACHUCA, ARIZ.—Fi
tests of a new battlefield remote c
trol system for surveillance drones h
just been successfully completed by
Army at its Electronic Proving Grou
here. Helicopter flight tests were flo
from nearby Cochise County Airp
at Willcox.

The system uses trailer-moun
radar and computing equipment
guide reconnaissance drones carry
cameras, radar, infrared sensors,
other devices to gather intelligence o
enemy or friendly territory.

Officially named Surveillance A
craft Flight Control System AN/UP
1, the equipment was developed
the Army Signal Corps by Ford
strument Division of Sperry R

orp. The complete system consists of dar, computer, plotting board and rtable power supply units mounted a trailer, and two auxiliary units— portable controller and an optical cker.

Designed for battlefield use, the ghly mobile system is rugged and htweight. It can be set up and put to operation in a very short time. Two en operate the equipment.

• **All-the-way control**—The AN/ PW-1 controls a drone flight from unch to recovery. The flight path of e drone is automatically traced on a otting board map on the trailer. As e drone takes reconnaissance pictures -by photography, radar, or infrared— its location at the time of exposure is automatically marked on the plotting map. Observations are thus related back to its precise location.

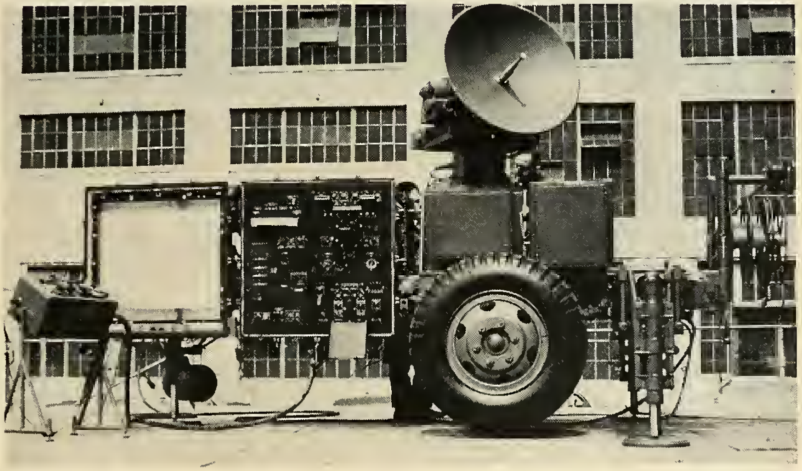
An internal telemetering link allows the control crew to monitor actions and events in the drone.

When its mission is completed, the drone is guided back to a predetermined recovery area, its engine stopped, and parachute released.

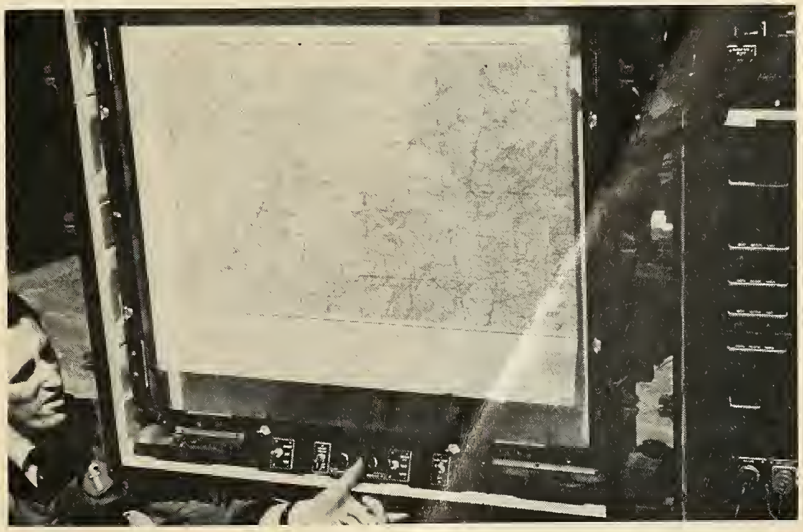
A portable "manpack" controller is included in the system to supplement the trailer unit. In cases where the trailer must be located away from the launch site, the portable controller can launch and visually control the drone until it can be taken over by the trailer radar. This portable unit can also be located at a forward post to take over operation of the drone for close visual control over surveillance targets.

An optical tracker, connected to the radar unit, is used as an aid in acquiring a drone returning to radar control. After visual acquisition, servo signals from the optical unit orient the radar which then takes over control.

Project officer for the flight tests was Mr. Otto F. Dworsky of the Ground Radar Division of the Combat Surveillance and Avionics Department, Fort Huachuca. Project engineer was Captain Augustus O'Brien of the Signal Corps Research and Development Laboratories, Fort Monmouth, N.J. A team of 28 military and civilian technicians took part in the Army tests. ⁂



ARMY'S AN/UPW-1 CONTROL system tracks surveillance drones by radar and remotely controls their flight over battlefield targets. Flight path is automatically plotted on map along with position data to mark observation locations. All primary units—radar, computer, control console, and plotting board—are trailer-mounted. Portable remote controller and optical tracker are also part of system.



Magnetic Film Thickness Gages

Mikrotest Dry Film Thickness Gages are available in two ranges—one for lacquers, enamels, etc. having a range of 0 to 20 mils, while the other model is for measuring platings, galvanizing, etc. This has a range from 0 to 2 mils. Both are available from the Nordson Co.

The two gages will measure a thickness of any non-magnetic coating on a magnetic (iron, steel, etc.) base. Maximum error is 10% + 0.0004.

Both of these instruments are extremely easy to use and both respond with a click that can be both heard and felt when the correct measurement is made.

An important feature of these gages is the fact that human differences in touch do not affect the readings. In other words, a number of workers can test the same coating and get the same result at a given spot.

Circle No. 225 on Subscriber Service Card.

Largest Voltage Divider

The largest precision resistor voltage divider built to date is manufactured at Resistance Products Co. The network was built on special order as a precision 30 megohm, 100 to 1 divider to operate at 30,000 volts with 0.05 accuracy. Independent tests established that ratio division was maintained within 0.01%.

Circle No. 226 on Subscriber Service Card.

Cryogenic Liquid Sampler

A device for obtaining accurate samples of cryogenic liquids is now available from Air Products, Inc. The batch sampler, which meets Air Force specifications MIL-P-25508B, will sample and prepare for analysis any low-boiling-point liquid.

Circle No. 227 on Subscriber Service Card.

Miniature RLC Filter

To the standard line of high performance broad band RF filters, DEVCO, Inc. has added another L-Cap. The characteristics of this unit exceed those of the standard L-Cap line which in themselves are unique in the electronic field. The L-Cap, significantly increases the low frequency attenuation characteristics of the basic L-Cap design while maintaining the inherent advantages of small size, light weight and unmatched high frequency attenuation. DEVCO laboratory tests have show better than 40 DB attenuation at 15 KC, rising to over 85 DB at one meg cycle. Insertion loss remains above 8 DB up to more than 1000 megacycle

Circle No. 228 on Subscriber Service Card.

E-M Radiation Meter

An advanced lightweight self-cor tained instrument for making accurat power density measurements of rad and transmitting equipment is bein manufactured by Sperry Microwav Electronics Co., Division of Sperr Rand.

In operation, a technician can rea power density directly on one of fou scales, from 0 to 20 mw/cm² over frequency range from 400 to 300 megacycles. An antenna and bolomete bridge are used only on the 0-20 m

range, while a second antenna, cryst detector and amplifier assembly a used on the three more sensitive range (0-.02 mw/cm², 0-.2 mw/cm², 0- mw/cm²). Designed for simplicity c operation, an adjustable control pr vides a red visual alarm light when th power density of any desired level reached.

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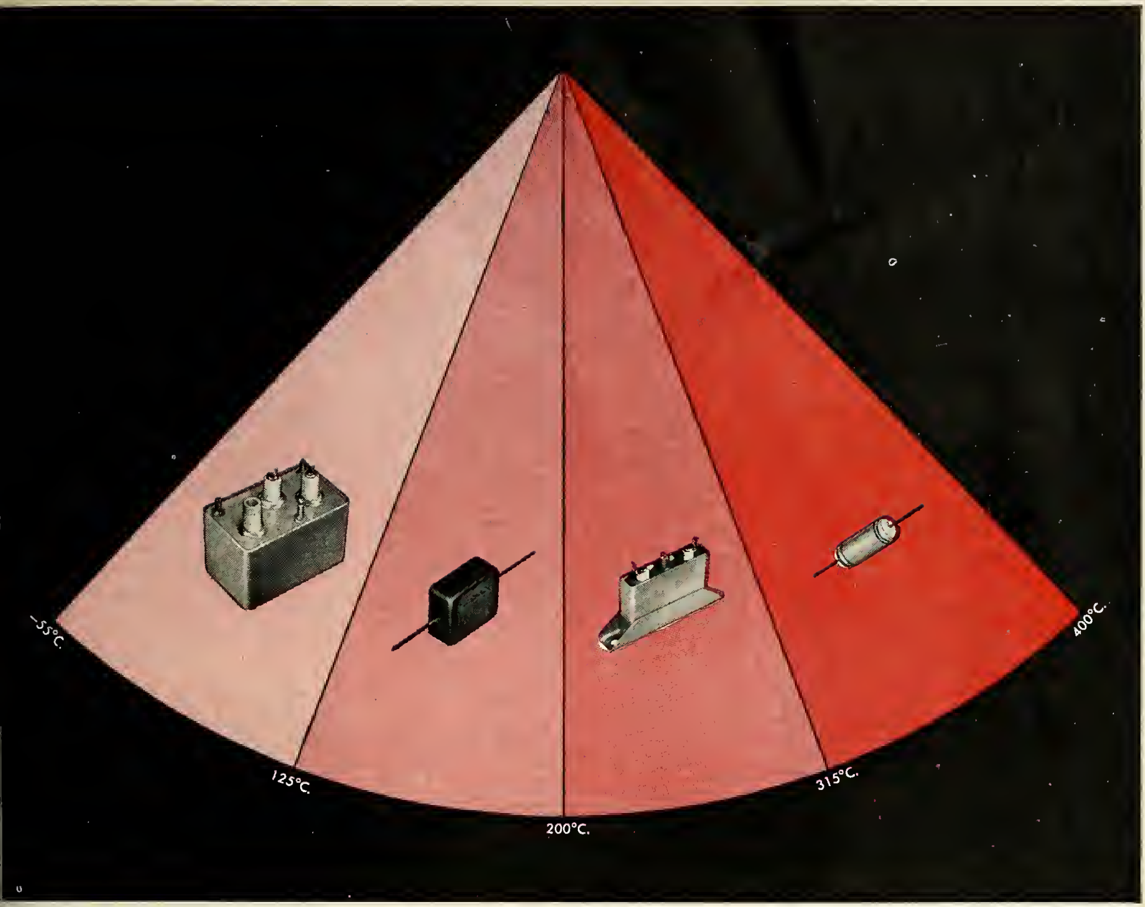
Wide Range Test Chamber

A temperature test chamber f –300° to 1000°F is available from Mi simers Inc.

Designed to be used with a vibr tion exciter in combined environment testing, this self contained chamber equipped with casters for portabilit and is adjustable in height to accomm date various sizes and types of vibratio shakers.

High temperature operation of th combination chamber is accomplishe by electrical heating with temperatur


-55°C.
125°C.
200°C.
315°C.
400°C.

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315°C. to 400°C.—In development • .001 to 6.0 uf, 150 V and 600 V • Drift—5% capacitance change typical from −55°C. to +426°C. • High I. R.—1 megohm X microfarad typical at 400°C. • Prototype availability • Only inorganic materials used.

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from ambient to +1000°F in 45 min. Expendable refrigerants provide the cooling, with CO^2 used for economy where moderate low temperatures are desired (ambient to −100°F) in approximately 20 to 30 min. For lower temperatures, liquid nitrogen is used for −90° to −300°F in 20 min.

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Dial Thermometer

A line of new magnetically attaching bi-metal dial thermometers is being manufactured by Industrial Service Co. for temperature measurement on ferrous materials.

The three styles of thermometers available are thermometers for temperature measurement only, thermometers with maximum reset hand and thermometers with electric contactor to permit "on-off" temperature control with electric resistance or induction heating.

The thermometers are available in various temperature ranges from −60°F to 700°F and have accuracies of better than 2%. They are held to steel and other ferrous materials by permanent Al Ni Co magnets.

Circle No. 231 on Subscriber Service Card.

DC Milliwatt Motor

A miniature DC motor, requiring as little as 0.3-v starting voltage and capable of operation from a solar source or use as a DC integrator, has been developed by Giannini Controls Corp. This milliwatt motor will operate on DC current for an appreciable time in a vacuum over a wide ambient temperature range and will withstand 50-g shock and 20-g random noise vibration.

Friction level is held very low by use of a small commutator, approximately 0.075 inch in diameter, and by use of cone pivot ball bearings. Gear reduction (5:1) is built as an integral part of the armature to reduce the friction level and to be compatible with cone-type ball bearings.

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Self Activating Stripper

Epoxy and polyester resins can now be removed from potted components 10 times faster without damage to parts or materials with a new self-activating stripper, Tele-Solv, developed by Electronic Components Division, Telecomputing Corp.

Tele-Solv will not corrode, discolor or otherwise affect copper, aluminum, ferrous metals or resin-based enamels. A controlled stripping agent, the Tele-Solv process can be stopped at any time for removal of small parts when complete de-potting not required.

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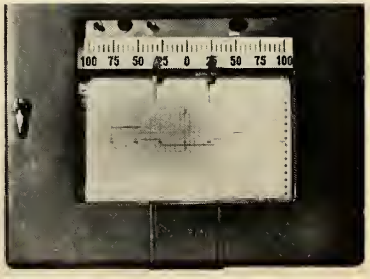
Strip Chart Recorder

Two strip chart recorders for use in indicating, recording or controlling dimensional variables, are available from Schaevitz Engineering.

The recorders, designated Models MR1SL and MR2SL to differentiate the single pen from the two pen units, feature the continuous null balance principle as their method of measurement. The accurate null balance system compares the output of an external linear variable differential transformer (LVDT) with a signal derived from an internal LVDT. The position of the balance system is indicated by the pen on the chart. A change in the measured variable results in an error signal to the amplifier input. The amplifier output drives the balance motor and pen to cancel the error signal.



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Transistorized Gaussmeter

A direct-reading, completely transistorized gaussmeter, combining the convenience of portability with high
sensitivity, has been designed, develop
and tested by F. W. Bell, Inc.

The instrument measures directi
and magnitude of magnetic flux densi
and reads from one gauss, full sca
to 30,000 gauss, full scale, in 10 rang
A principle innovation in the Mo
(No. 110) is the Zero Center Me
which indicates immediately the dire
tion being read and does away with a
necessity for a reversing switch.

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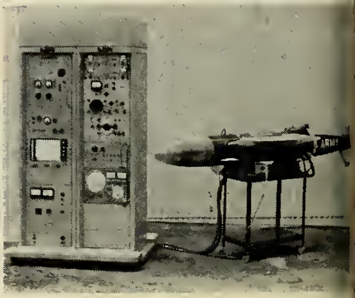

Target Missile Checkout

R S Electronics Corp. has design
and produced several preflight chec
out systems for use with the RP-
Rocket Powered Target Missile. T
System tests the performance of t
missile tracking, guidance, radio a
safety equipment. An important s
tem feature includes automatic a
fail-safe operation. Operation of
electronic and electrical subsystems c
be verified.

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Flexible, thin, reinforced plas
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elements are available from Riversi
Plastics Division of the Bischoff Che
ical Corp.

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various watt densities with maxim
surface temperatures in the 400°
500°F range. Sheets only 0.021
thick resist electrical breakdown
saline immersion under 250 volts.

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our-Way Air Valve

A 4-way, ¼ in. 5-ported pilot-oper-
ed air valve has been developed by
lkon Products Corp. for a wide vari-
y of bleeder operations. It is capable
over 1000 cycles per minute and has
life expectancy exceeding 50,000,000
cles.

Small bleeder operators which fea-
re a hardened ball nose plunger can
mounted anywhere, thus saving pip-
g and wiring costs. Operators can
mounted so they will be tripped by
e moving parts of machinery. They
n also be used as a 2-way normally
osed valve in other circuitry require-
ents.

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djustable Sequence Timer

Acton Laboratories Inc., a sub-
iary of Technology Instrument Corp.,
marketing a new miniature adjustable
quence timer Model 4-23—a 3 in.-
ide lightweight timer featuring micro
justable cams that can be easily and
ickly set within 0.1% of the total
riod.

The unit surpasses specification
IL-E-5272C for vibration, shock and
celeration. Its accuracy exceeds 3%.
e adjustable time span is 1 second to
minutes.

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uorocarbon Fluid Seals

Fargo Rubber Corp. has developed
elastomeric compound with capa-
ities for seals, O-rings, and packings
precision instruments and systems
ntaining fluorocarbon fluids and lu-
cants, and helium gas.

Accelerated service tests involving
ultaneous interexposure of the new
npound, FR 6-60-13, fluoroester
ohol, fluorocarbon oils, and copper
ulted in no discoloration of the fluid,
no corrosion of the metal.

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ur Electrode Switch

The Burroughs Corp. announces the
roduction of a multiposition elec-
nic switching device with a four-
ctrode structure per position. The
rth electrode, called the shield grid,
been incorporated in the BEAM-X
itch, Type BX-1000. The shield grid
kes possible three new functional
racteristics—a "straight-line" or
stant switching input requirement
ffected by output level, target op-
tion over a wide range of output
ages never before possible; and the
ration of devices having non-linear
ing characteristics.

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new literature

MOUNTING SENSING ELEMENTS—A bulletin describing methods of mounting temperature and strain measuring elements by means of ROKIDE ceramic spray coatings is available from Norton Co. This technique is being used to mount such elements in areas subject to high temperatures, such as rocket nozzles, gas turbines, and nose cones, particularly in testing operations.

Circle No. 200 on Subscriber Service Card.

TANTALUM SLUG CAPACITORS—The line of tantalum slug wet electrolytic capacitors is covered in an Ohmite Manufacturing Co. release, Bulletin 159E. With two new case sizes added, Ohmite is now supplying all three case sizes called for by military specification MIL-C-3965B, for Styles CL44 uninsulated, CL45 insulated. The bulletin lists as stock all the MIL capacitance and voltage values called for in these sizes.

Circle No. 201 on Subscriber Service Card.

SPACE ANTHOLOGY—A compilation of five technical articles, four of which deal with the application of Doppler principles to space navigation, is available from GPL Division of General Precision, Inc. The fifth explores the possibilities of untraviolet's having space signal value.

Circle No. 202 on Subscriber Service Card.

AUTOMATIC MEMORY CORE HANDLER—Technical Bulletin 60-A from Rese Engineering Inc. describes Model CH-58 Automatic Memory Core Handler, a fully automatic, production type, memory core feeder which grades and sorts standard 80 mil or 50 mil miniature ferrite cores at continuous operating speeds of over 16,000 cores per hour. The two-page illustrated bulletin fully describes the machine's electro-mechanical operation for both semiautomatic laboratory analysis and full-scale production testing.

Circle No. 203 on Subscriber Service Card.

CAPACITOR CATALOG—A Manufacturers' Capacitor Catalog has been published by Centralab, The Electronics Division of Globe-Union, Inc. The 20-page book covers the complete line of Centralab general-purpose disc and tubular ceramic capacitors. Included are detailed specifications on temperature-compensating, temperature-stable and semi-stable, bypass, high- and low-voltage types as well as Tube-R-Cap resistor-capacitor combinations.

Circle No. 204 on Subscriber Service Card.

RADIO INTERFERENCE CONTROL—A technical paper recently presented by Fred J. Nichols, President of Genistron, Inc. at the Fourth Conference on Radio Interference Reduction and Electromagnetic Compatability sponsored by the Armour Research Foundation of Chicago, Illinois has been printed into a 32-page booklet. The paper discusses in detail the radio interference spectrum and associated problems encountered with the use of diodes. Included are copies of actual test results.

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missiles and rockets

2nd ANNUAL MISSILE/SPACE MATERIALS ISSUE

- *What problems missile makers face in coping with temperatures from—459°F to 15000°F.*
- *What materials missile suppliers have available to meet missile/space requirements.*
- *Encyclopedia of materials now used in major missile an space projects.*
- *Missile/space materials requirements of government an military agencies.*

Advancement in materials remains one of the most critica problems facing today's missile/space industry. Material used in the structures of missile and space vehicles face unprecedented temperature extremes. Temperatures may ris as high as 15000°F in rocket nozzles. And they fall as lov as −434°F in liquid hydrogen fuel tanks and outer space.

The problems of high and low temperatures will be explore in depth in Missiles and Rockets 2nd Annual Missile/Spac Materials issue. In a series of articles, *materials specialist* for prime missile and space vehicle contractors will outlin their requirements in high and low temperature areas. T round out the picture, M/R Editors will also detail th materials needs of government agencies. In a second majo section, *missile suppliers* will discuss developments in spac age materials and their performance at high and low temperature extremes.

A new Missile/Space Materials Encyclopedia will provid an extensive review of the materials currently being used i major missile and space projects. Compiled in easy-to-us form, this encyclopedia will bring together information no available from any other single source.

If you have a materials or capability story this specia editorial issue is doubly important to you. First, it enable you to capitalize on the major attention which it will focu on the critical area of missile/space materials. Second, yo reap the benefits of repeat readership and long reference lif which result from this once-a-year undertaking.

Plan now to take advantage of the intense interest which thi issue will generate among technical management and engineering readers in every phase of the missile/space market For additional information, contact the **MISSILES AN ROCKETS** regional advertising manager in your area.

Published November 28, 1960

Closes November 7, 1960

contracts

AIR FORCE

erojet-General Corp., Azusa, Calif., for *Ablestar* second-stage boosters to be used in future launchings of *Transit* and *Courier* satellites.

'exas Instruments, Inc., Dallas, for work on Project *VELA*, a program for developing methods of detecting and identifying nuclear explosions.

4,400,000—Avco Corp.'s Lycoming Div., Stratford, Conn., for production of additional missile rocket chambers. Subcontract from Aerojet-General Corp.

1,000,000—The Martin Co., Baltimore, for repair and modification of AN/DJW-4 inertial guidance systems and components and related ground support equipment for the *Mace*.

940,000—General Electric Co., Schenectady, for electron tubes.

466,720—RCA Service Co., Camden, N.J., for architectural engineering services and engineering studies for final design of aerospace systems environmental Chamber Mark I.

79,075—Radio Corp. of America, for electron tubes.

74,951—The Emerson Electric Manufacturing Co., St. Louis, for inspection, test and repair of major components and subassemblies of the MD-7 fire control system.

50,000—Crosby-Teletronics Corp., for *Atlas* missile guidance system test equipment. Subcontract from The Arma Div. of American Bosch Arma Corp.

47,124—Sylvania Electric Products, Inc., Salem, Mass., for electron tubes.

NAVY

and-Air, Inc., Chicago, for electronics engineering services in the field of electro-mechanical and electrical equipment used with radar and fire control systems.

ackard Bell Electronics Corp., Los Angeles, for producing a key portion of *Transit*, a satellite-controlled navigation system. Subcontract from Applied Physics Laboratory of Johns Hopkins University.

200,000—Gladding, McBean & Co., Los Angeles, for further production of ceramic radomes for the *Sparrow III*. Subcontract from Raytheon Co.

ARMY

50,000,000—Douglas Aircraft Co., Santa Monica, for research and development of the *Nike-Zeus*. Subcontract from Western Electric Co.

2,000,000—Telecomputing Corp., Los Angeles, for guidance and control gyros to be used in the *Nike-Hercules*. Subcontract from Western Electric Co., Winston-Salem.

1,374,317—The W. L. Maxson Corp., New York City, for further work on components for the *Hawk* missile.

1,359,000—Aerojet-General Corp., Azusa, Calif., for rocket motors for the *Hawk* missile.

799,990—Sperry Rand Corp., Salt Lake City, for research and development on the *Sergeant* missile system.

542,170—Raytheon Co., Waltham, Mass., for concurrent repair parts for the *Hawk* missile system.

79,460—Douglas Aircraft Co., Inc., Santa Monica, for *Nike* repair parts.

54,752—Sperry Rand Corp., Salt Lake City, for *Sergeant* missile ground handling equipment.

17,331—Harvey Aluminum Inc., Torrance, Calif., for production engineering study.

NASA

,087,692—Hayes Construction Div., Inc., a subsidiary of Hayes Aircraft Corp., Birmingham, Ala., for installation of fueling and launching equipment at the *Saturn* launch facility, Cape Canaveral.

07,914—Brown Engineering Co., Inc., Huntsville, Ala., for ground equipment test set, engineering, fabrication and related services.

15,994—Linde Co., Birmingham, Ala., for liquid oxygen and liquid nitrogen.

MISCELLANEOUS

orkey-Moore Associates, Torrance, Calif., for production of transponder test units. Contract from Convair Astronautics Div., General Dynamics Corp.

05,200—The Electrada Corp., Beverly Hills, Calif., for titanium pressure vessels for missiles. Subcontract from Lockheed's Missile and Space Div., and Convair's Astronautics Div.

50,000—Houston Fearless Corp.'s Marchetti Div., Natick, Mass., for design and manufacturing of communications subsystem for the Atlantic Missile Range.

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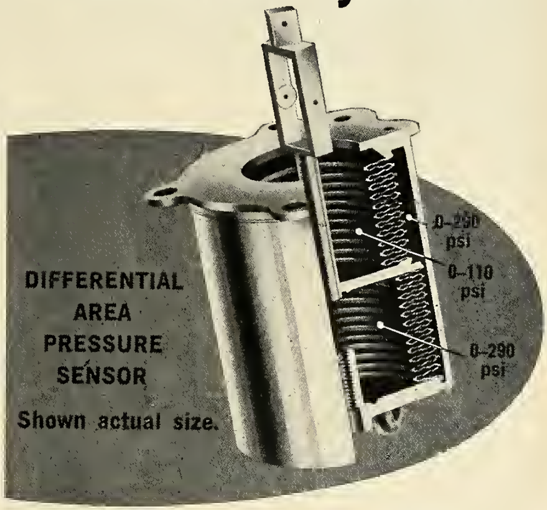
Outstanding As Pressure Sensors In Force Rebalance Systems



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names in the news

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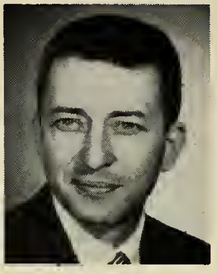
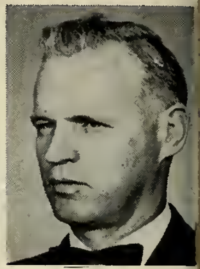

JACK


OGLETREE

Walter T. Bonney: Appointed director of public information for Aerospace Corp. For the past two years he has been director of the office of public information for the National Aeronautics and Space Administration.

Donald Lincoln Herr: Former president of Mark Instrument Co. joins the engineering staff of Belock Instrument Corp. as a specialist in design and development of miniaturized computer and control components.

Stephen Jack: Former missile and space systems sales engineer for United Aircraft Corp. joins the Northrop Corp.'s Norair Division as chief of astronuatics marketing.

William F. Kyle and **John A. Williams Jr.:** Join the Data Storage Dept., Information Technology Div. of Lockheed Electronics Co. Both were formerly associated with the Ampex Corp.

Dr. William J. Jacobi: Appointed vice president of Litton Systems, Inc., and general manager of the Guidance and Control Systems Division. He has been with Litton Industries since 1958 as director of advanced systems engineering for the Electronic Equipments Div.

Brig. Gen. Lester W. Light (USAF-ret.): Appointed director of Government Relations for Transval Electronics Corp.

Mike Cannon: Named director of public relations and advertising for General Precision, Inc.'s Librascope Div., succeeding **Ken Slee.** Was formerly advertising manager for the division.

L. Peter Retzinger: Appointed director of the Computer Systems Laboratory of the Guidance and Control Systems Div. of Litton Systems, Inc. **Francis Dedona** is now assistant director of the laboratory.

Alfred Strogoff: Former vice president of marketing elected vice president and general manager of Adler Electronics, Inc.

Sergio A. Alessio: Named senior staff engineer, Staff Research and Engineering, Amphenol-Borg Electronics Corp. Was formerly associated with Bell and Gossett Dualex Div. and Panellit, Inc., where he had major responsibility for design and development of digital data processing systems and components.

William G. McLoughlin: Appointed chief of research at Del Mar Engineering Laboratories. Was formerly chief of research for The Hayes Corp.

George D. M. Peeler: Named Senior laboratory director of the Aero Geo Astro Corp. Was manager of the Microwave Development Dept. Missile Systems Div. of the Raytheon Co. where his work centered around the *Sparrow III, Hawk, Nike Zeus, Polaris* and other weapons systems.

W. A. Ogletree: Former manager of engineering for the Military Electronic Computer Div. of Burroughs Corp., joins Computer Systems, Inc. as general manager.

Walter S. Attridge, Jr.: Former associate head of The Mitre Corp.'s Weapons Control and Sensor Systems named head of the department.

Dr. Gilford G. Quarles: Chief scientific adviser of the U.S. Army Corps of Engineers appointed to the new post of director for long-range military planning for The Bendix Corp.

Roland P. Andelson: Named assistant manager in charge of Hughes Aircraft Co.'s ground systems group activities in Washington, D.C. succeeding **James E. McHenry** now assigned to the Fullerton facility as manager of the industrial sales department.

Tore N. Anderson: Executive vice president moves up as president of FXR, Inc. succeeding **Henry Feldmann,** who moves into the newly created post of board chairman.

A. N. Brown: Former vice president-sales for Bach-Auricon, Inc. joins Magnasync Corp. as marketing manager of the firm's Nomad Division.

Brig. Gen. Don Flickinger: Assigned staff supervisor for the Air Research and Development Command's bioastronautics research program. He also serves as assistant for Bioastronautics to **Lt. Gen. B. A. Schriever.**

John W. Maybaum: Former assista general sales manager of U.S. Industrie Solar Chicago Div., joins Vacudyne Cor as sales manager.

Roland (Bud) Carlson: Former exec tive assistant to the Army's Chief of R search and Development joins The Ma tin Co.'s corporate staff at Baltimore.

Melvin B. Zisfein: Appointed manag of Giannini Controls Corp.'s new formed Astromechanics Research Div sion. Was formerly chief of Aeroelasti ity at Bell Aircraft Corp.

Richard C. Hensbaw and **Stephen W Carter:** Named vice president-operation and vice president industrial relations, r spectively, at Lord Manufacturing Co.

Frank C. Bumb, Jr.: Appointed vic president-engineering for American Con certone, Inc., a Division of the Astr Science Corp.

Michael A. Auro: Joins the marke ing staff of Kay-Fries Chemicals, In Was formerly associated with Dow Chemi cal Co.

James A. Ross: Former engineeri department manager promoted to equip ment division manager.

George Dunn, Jr.: Named senior de velopment engineer for Silicon Transisto Corp. Was formerly an engineer wit RCA's Advanced Development Group.

Norman Altman: Field sales manage for Magnetics, Inc. joins Norbatrol Elec tronics Corp. as director of marketing, newly created post.

Herbert K. Weiss: Elected manager o Military Systems Planning for the Tech nical Staff at Ford Motor Co.'s Aero nutronic Div. **Morgan M. Blair** succeed him as manager of Advanced System Development.

Eugene J. Ziurys: Former engineer fo advanced design in General Electric Co. Aircraft Nuclear Propulsion Laboratory joins Thompson Ramo Wooldridge Inc. as a consulting engineer in Preliminar Design department of Tapco Groups' Ne Devices Laboratories.

Innovations . . .

(Continued from page 38)

be bent and models constructed to test the feasibility of ideas.

The attractive features of this approach are that it would provide a systematic way of testing new ideas and that the testing would occur when the costs are lowest in the development cycle. Some variation of this approach must surely lie in the future of military research and development. Costs notwithstanding, urgency and complexity demand a reduction in the time necessary for the acceptance of new theories. Such a reduction will result if our approach is changed from archeology to exploration, from applying the principles of the past to proposing theories for the future.

The rate of technological advance, the "explosion," bears a marked similarity to the rate of population growth. However, the discoveries which gave impetus and direction to this growth still are the consequence of the appearance of men of genius. Their appearance on the scene of history cannot be forecast. Past experience would indicate that the individuals who give direction to science appear only once in each century. If this is so, this century has already seen its most significant advance. We must mark time until history gives us our next genius.

This is a theory which is based on the assumption that history occurs and is not made. If we base our analysis of the future on the assumption that history is the record of human action, i.e., purposeful action toward selected goals, we can hope to stimulate the appearance of genius and thus look for major advances in technology. An effort to break with this theory lies beyond the military sphere. It can come only from our society at large.

In a century characterized by and dependent on innovation, it is a remarkable fact that a systematic effort has not been made to study and stimulate innovation.

The importance of cultivating this talent is seen in the fact that, regardless of which strategy the military man follows in research and development, the key to future weapons is the strategy followed by the scientist. The scientist warns the military man to avoid "product improvement programs"—they produce only incremental advances for large investments. The military man should also be aware of the difficulties of "idea refinement programs."

Intellectual innovations are as important as weapons system innovations. Awareness of this fact, together with measures which make realities of ideas, is essential to future technological strategies. ⌘

when and where

OCTOBER

ASME-American Society of Mining, Metallurgical and Petroleum Engineers, Fuels Conference, Daniel Boone Hotel, Charleston, W.Va., Oct. 24-25.

Medical and Biological Aspects of the Energies of Space Symposium, sponsored by USAF Aerospace Medical Center (ATC), Granada Hotel, San Antonio, Tex., Oct. 24-26.

Seventh Annual East Coast Conference, Aeronautical and Navigational Electronics, Lord Baltimore Hotel, Baltimore, Oct. 24-26.

Government Contracting Course, National Defense Education Institute, sponsored by NSIA and Harbridge House, Inc., Detroit, Oct. 24-Nov. 4.

Eleventh National Conference on Standards, Sheraton-Atlantic Hotel, New York City, Oct. 25-27.

1960 Computer Applications Symposium, Armour Research Foundation of Illinois Institute of Technology, Morrison Hotel, Chicago, Oct. 26-27.

1960 Computer Applications Symposium, sponsored by Armour Research Foundation, Morrison Hotel, Chicago, Oct. 26-27.

AIEE-IRE Conf. on Non-Linear Magnetics and Magnetic Amplifiers, Bellevue-Stratford Hotel, Phila., Oct. 26-28.

IRE Professional Group on Electron Devices Meeting, Shoreham Hotel, Washington, D. C., Oct. 27-28.

IRE, 13th Annual Conference on Electrical Techniques in Medicine and Biology, Sheraton-Park Hotel, Washington, D.C., Oct. 31-Nov. 2.

1960 Fall Radio Meeting, sponsored by Electronics Industries Association, Engineering Dept. and IRE Professional Groups, Hotel Syracuse, Syracuse, Oct. 31-Nov. 2.

NOVEMBER

Conference on Electrostatic Propulsion, ARS and U.S. Naval Postgraduate School, Monterey, Calif., Nov. 3-4.

Government Contracting Course, NDEI, sponsored by NSIA and Harbridge House, Inc., Dayton, Nov. 7-18.

First National Die Casting Exposition and Congress, Society of Die Casting Engineers, Detroit Artillery Armory, Detroit, Nov. 8-11.

National Convention, National Aeronautics Association, Indio, Calif., Nov. 14-16.

Sixth Annual Conference on Magnetism and Magnetic Materials, sponsored by: AIEE, American Institute of Physics, ONR, Institute of Radio Engineers, American Institute of Mechanical Engineers, New Yorker Hotel, New York City, Nov. 14-17.

IRE Mid-American Electronic Convention, (MAECON), Hotel Muehlebach, Kansas City Mo., Nov. 14-16.

IRE 4th Annual Conference, Professional Group on Production Techniques, Sheraton Plaza Hotel and Commonwealth Armory, Boston, Nov. 15-16.

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editorial . . .

The FCC Gives Away a Public Heritage

THE RECENT ACTION of the Federal Communications Commission in throwing open the microwave spectrum above 890 megacycles for private, point-to-point communications reveals an incredible lack of vision and a remarkable lack of concern for conserving a valuable natural resource.

This communications area, which normally carries from 890 megacycles to 10,000 as a matter of power practicability, is the last remaining uncrowded region for space communications.

Upon its proper allocation and utilization depends our global ground-to-ground communication by satellite, as well as our future communication with space vehicles and celestial bodies—or between any of these.

In a report prepared for the Senate Space Committee, Edward Wenk, Jr., senior specialist in science and technology of the Legislative Reference Service, writes:

"Within only a few years, literally hundreds of space vehicles will most certainly be launched, each with its peculiar demand for radio communication.

"With the apparently unlimited breadth of the radio frequency spectrum, it would appear at first glance that an exceedingly large number of transmitters could operate side by side in the spectrum without interference. The facts, however, indicate that this is by no means so.

"In the first instance, much of the band is already allocated to other uses and the practical problems of massive allocation render this course of action unacceptable.

"Next, not all of the remaining unsaturated frequencies are suitable for space communication. That is, by virtue of the low power and small size of antenna, of the propagation characteristics of the upper atmosphere and other technical factors, only certain of the frequencies can be effectively utilized for space."

By its October 5 decision, the FCC denied the pleas of scientists and of the large U.S. "common carriers" of communication that a portion of this 890-10,000 mc area be set aside for future public use.

Instead, it threw open the entire area for private, point-to-point communication.

In refusing to reserve any portion of the spectrum, the commission voted six to one that space communication would not become necessary "for 20, 30 or 40 years." The commission also felt that the scientists and common carriers were asking for too great an area reservation.

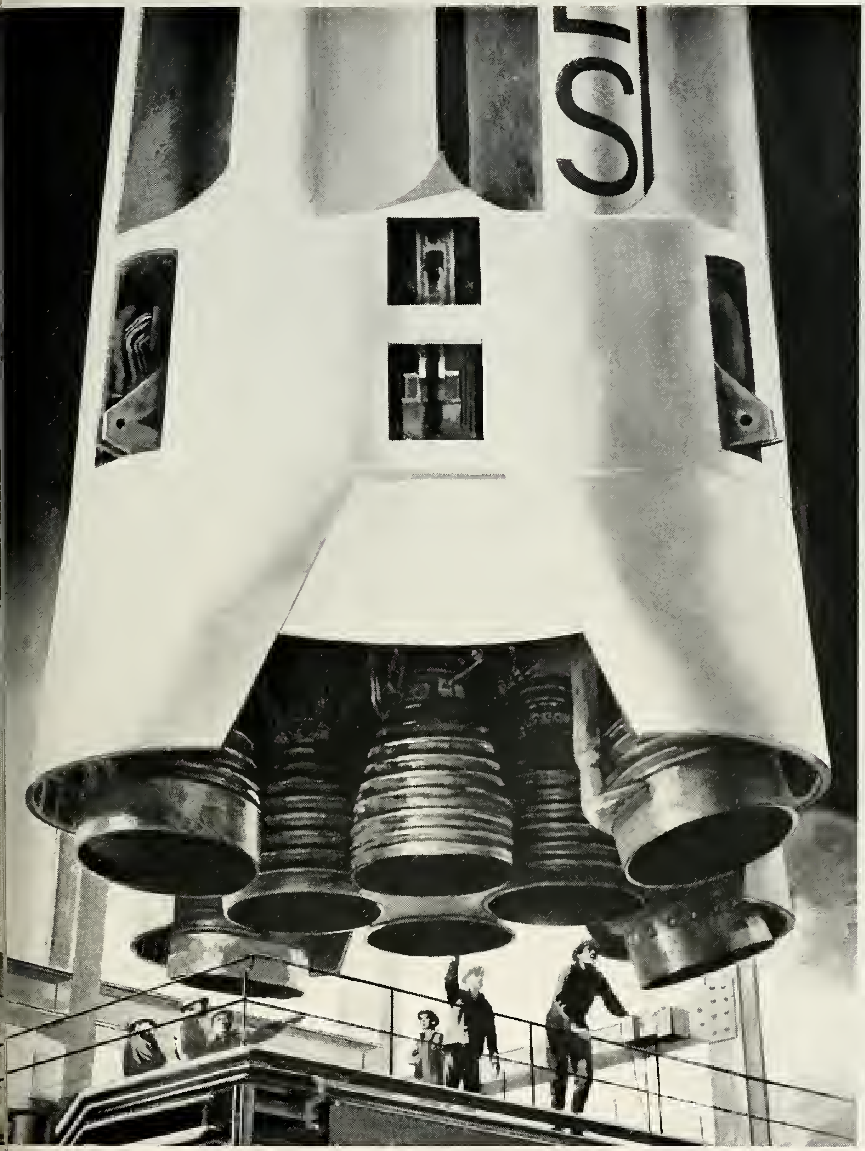
So the commission decided to give the entire spectrum away.

AT FIRST GLANCE this action might seem to be a decision against big business and in favor of the little man who wants a private communication system for perhaps 200 miles.

Actually, the decision is against Joe Doakes, the ordinary citizen who uses the telephone, sends telegrams and cables, listens to the radio and watches television. All of these services can be provided worldwide via satellite—and they are not 20, 30 or 40 years off. They are feasible and likely within the next two to five years, through international cooperation—if the necessary communications bands are left free.

The shortsightedness of the FCC lies not in giving radio space to the point-to-point users. It lies in giving it *all* to them. Certainly it makes sense to reserve enough of the spectrum for public and scientific use—whether for television of the Olympic games in Japan in 1964, or for communications with a space ship at about the same time.

Clarke Newlon



The first version of *Saturn* will be 185 feet tall . . . 21 feet across the base . . . will contain 14 rocket engines!

Douglas-built second stage is as tall as a 5-story building.

The rocket that will lead the way to space travel is now in development

Space researchers at Douglas Aircraft are already working on the design and construction of the second stage of the huge NASA *Saturn* rocket.

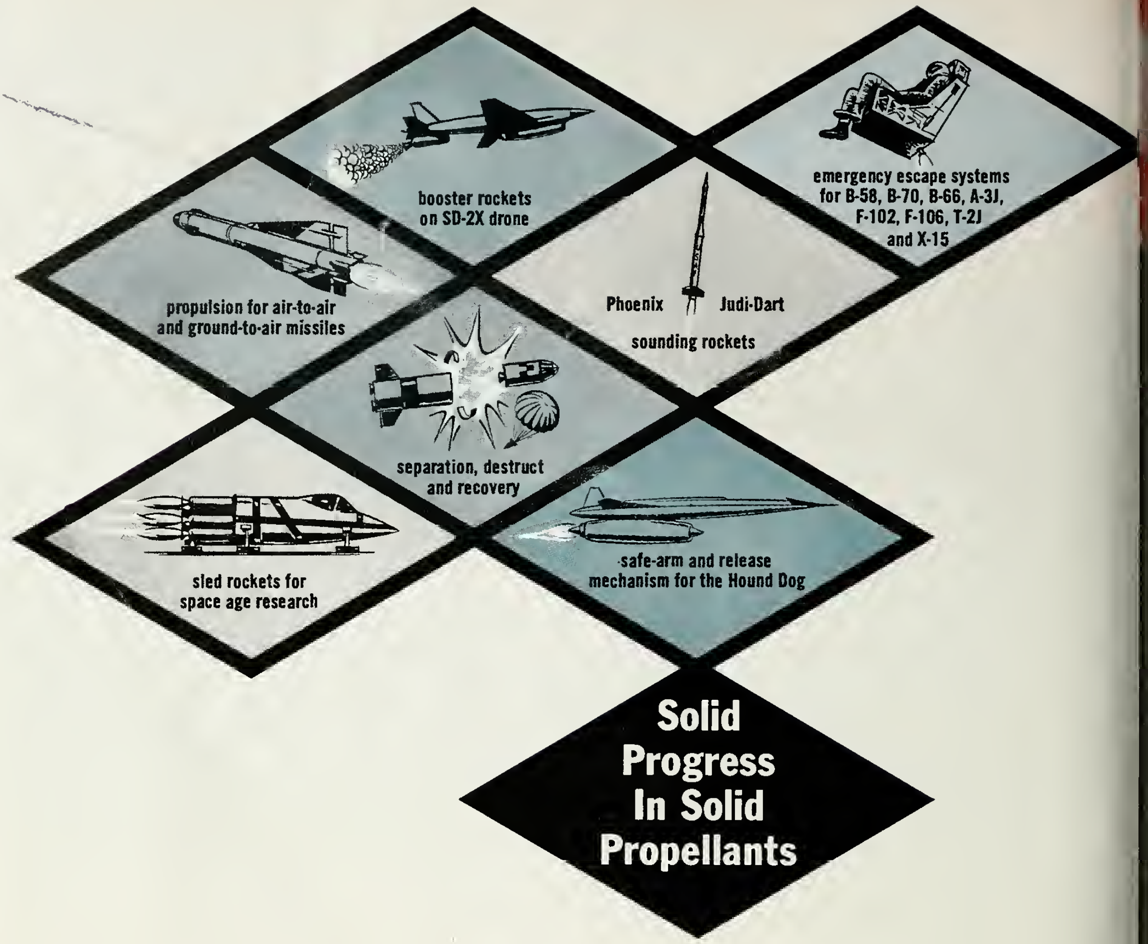
Saturn is the first program which s designed, from the ground up, to provide the capability of putting tons of payload into orbit or thrusting manned capsules beyond the earth's pull. It will initially be able to orbit 20,000 pounds around the earth, or deposit 6,000 pounds on the moon.

Future configurations of *Saturn* will have even greater thrust and payload, paving the way for round trips to the planets.

Fantastic as these predictions sound, they are the solid convictions of the men at Douglas whose skills have been behind the production of nearly 30,000 rockets, missiles and space vehicles. These include the *Thor* IRBM which has boosted more successful space payloads than all other U.S. boosters combined.

DOUGLAS

MISSILE AND SPACE SYSTEMS • MILITARY AIRCRAFT • DC-8 JETLINERS • TRANSPORT AIRCRAFT • AIRCOMB® • GROUND SUPPORT EQUIPMENT • ANTI-SUBMARINE WARNING SYSTEMS



Space Age Support *from* ROCKET POWER / TALC

During the past twelve months the Rocket Power/Talco team has proven its capability b accomplishing such space-age developments as –

- The Phoenix . . . a 250 mile sounding rocket
- booster rockets for the SD-2X drone
- rocket-propelled escape systems for the X-15, B-70, F-106 and other operational aircraft
- the safe-arm and release mechanism for the Hound Dog
- the Judi-Dart . . . a 50 mile meteorological rocket
- a variety of high-performance, on-the-shelf sled and booster rockets

For the future, RP/T is pioneering research in solid propellants, exotic fuels and other energ forms. ◆ Rocket Power's complete, proven capability is ready to assist you in your next soli propellant, rocket, or ballistic system requirement. Write for complete information.

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OCTOBER 31, 1960

issiles and rockets

HE MISSILE/SPACE WEEKLY

OCT 1960
HOUSTON PUBLIC

unching of Army's Courier 1B

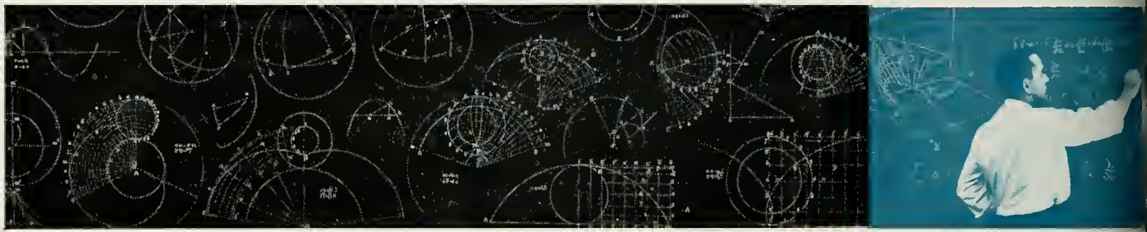
NSWER TO M/R OPEN LETTER

ixon Takes Defense/Space Stand . . . 10

AN AMERICAN AVIATION PUBLICATION

LIBRASCOPE COMPUTER FACILITIES

Shown below is a composite view of Librascope's facilities wher a variety of computer systems are currently in different stage of design and production. Some are strategically involved wit national defense...others deal with business and industrial proces control. Each is uniquely designed to answer a particular need. Th success of these systems illustrates the value of Librascope' engineering philosophy: A decentralized organization of spe cialized project teams responsible for assignments from concept t delivery...and backed up by excellent research, service, and production facil ities. For your computer requirements, call on the company whose breadt of diversification in computer technology is unsurpassed. ■ Librascop Division, General Precision, Inc., 808 Western Avenue, Glendale, Calif For career opportunities write to John Schmidt, Engineering Employment. ■



computers that pace man's expanding mind

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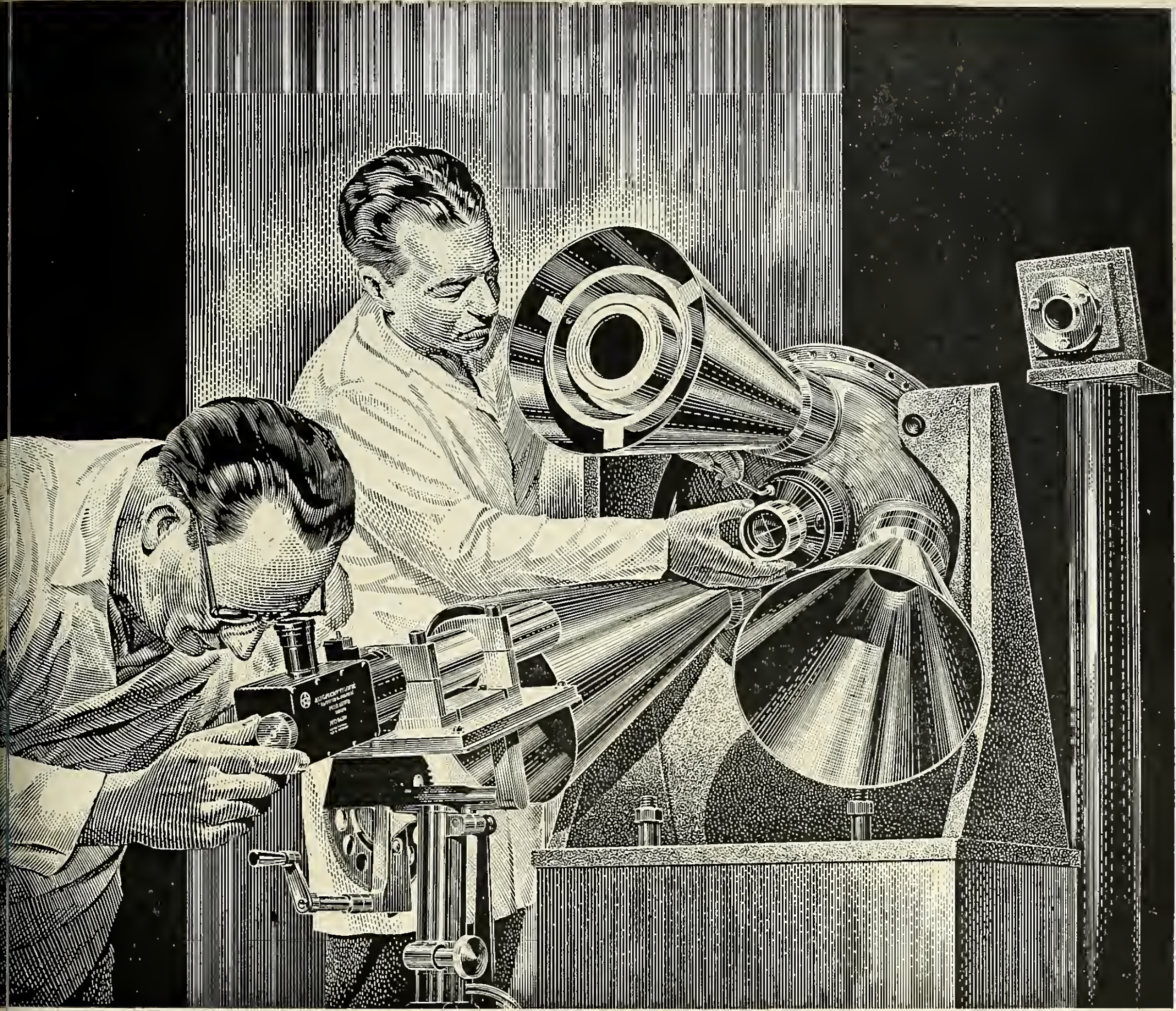

The optically precise calibration of nozzle alignment on a Mercury "Man-in-Space" Rocket Motor is typical of the personal approach applied to a customer's requirements which goes "beyond the specifications." Mercury Motors as developed by GCR achieve a reliability of 99.9%.

rand Central Rocket:

The Personal Approach That Saves Project Time

It is a firm policy at Grand Central Rocket to have our top-ranking solid propellant scientists deal directly with our customers. The result is a personal approach to handling the intimate details of each client's problem—an approach that goes "beyond the specifications."

This *personal approach* is backed by Grand Central Rocket's growing technical resources; today hundreds of scientists, engineers, and technicians work on a large number of research and production problems in an excellent and growing solid propellant plant.

Developers of solid propellant motors for Mercury "Man-in-Space," Mauler, Nike Zeus, NASA Space Booster, lunar landing and space probes as well as the Wolf motor, M-motor and hybrid motors. Producers, with "on the shelf" availability, of Javelin, Lance, Viper, Meteor, Jato, Fang, Sword and Saber motors. Positions open for chemists, engineers and solid rocket production specialists.

GCR
GRAND CENTRAL ROCKET CO.

AN INDEPENDENT AFFILIATE OF LOCKHEED AIRCRAFT CORPORATION and PETRO-TEX CHEMICAL CORPORATION—P.O. BOX 111—REDLANDS, CALIFORNIA—TELEPHONE PYramid 3-2211.

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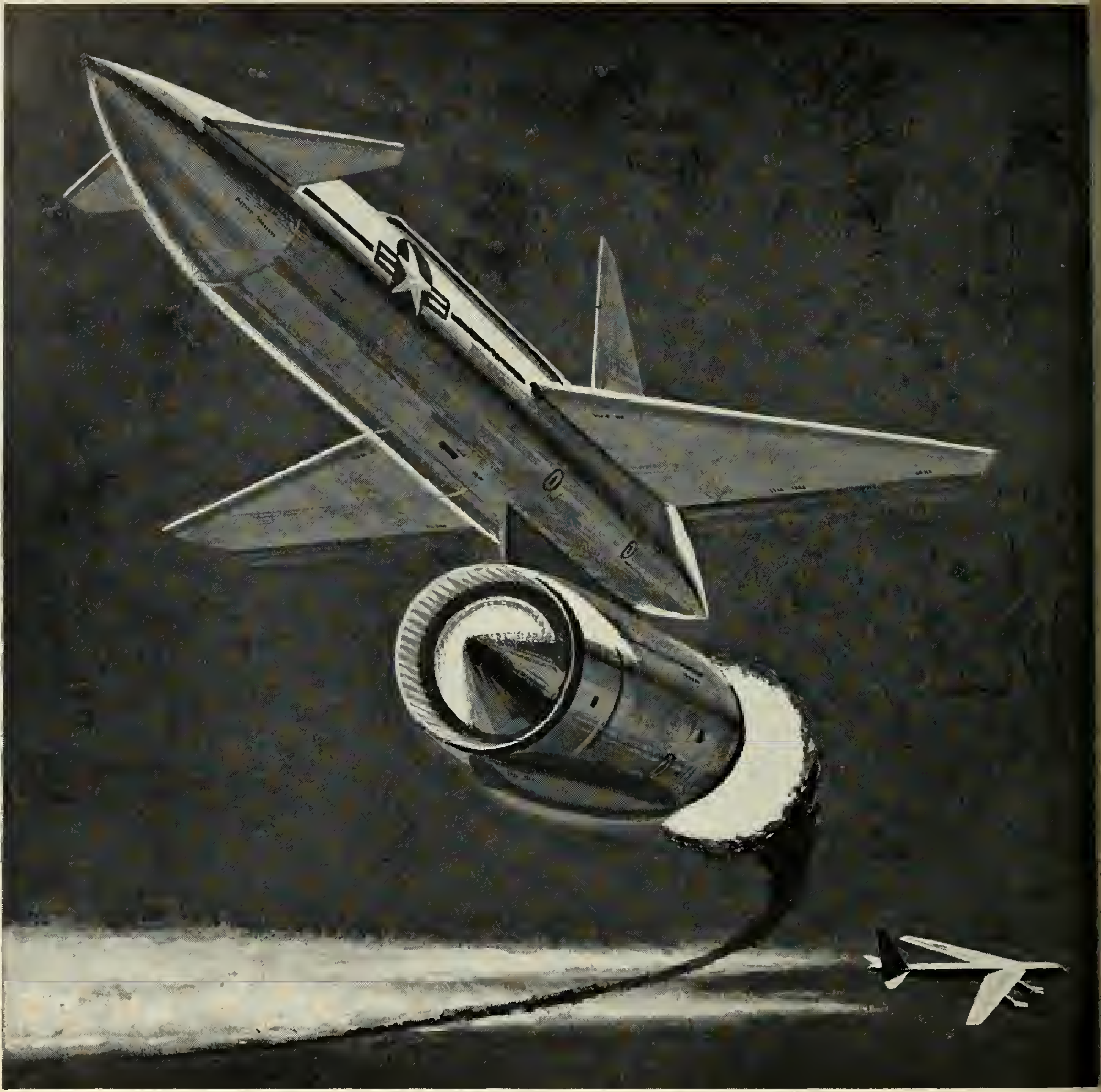

HOW SAC'S HOUND DOG CONFUSES ITS QUARRY

When the GAM-77 HOUND DOG strategic missile leaps into action from a B-52G intercontinental bomber, its pre-set controls can veer it off in a direction *away* from the target. It can change course and altitude. Then, with enemy defenses confused, it can turn suddenly and bear down on the target at supersonic speeds. Its guidance system can't be jammed... can't be decoyed. It can reach out hundreds of miles to destroy its quarry.

Outstanding capabilities such as this make the GAM-77 HOUND DOG missile an extremely valuable weapon for SAC. The HOUND DOG has already been tested and proved in flight conditions. It is operational hardware *in being.* And in addition, it has growth potential in range, speed, and payload stretching through many years to come.

THE MISSILE DIVISION OF NORTH AMERICAN AVIATION, INC.
Downey, California

HE MISSILE SPACE WEEKLY

missiles and rockets

October 31, 1960 Volume 7, No. 18

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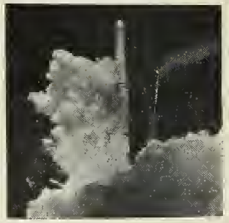
THE COVER



The highly successful launching of Army's Courier 1B from Cape Canaveral on Oct. 4. The communications satellite went into orbit on an AF Thor-AbleStar vehicle.

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VIGILANCE

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The Countdown

WASHINGTON

ear New Soviet A-Weapons

Top U.S. officials are deeply worried that Russia secretly may be developing "entirely new" nuclear weapons. The Soviets, these officials point out, could be testing the warheads for the weapons far underground—where they can't be detected. The new weapons may be tied to Russia's expanding space technology.

ennedy Oversight

Senator Kennedy's advisors are now advising that his failure to include the B-70 in his response to M/R's open letter Oct. 10 was an oversight. He's in favor of building it; so's Nixon (see p. 10).

dvancing Polaris

R&D schedule for the Navy's 1500-mile and 2500-mile *Polaris* now looks like this: The 1500-mile A-2 *(Polaris II)* is expected to be operational by early 1962 or late 1961. The 2500-mile A-3 *(Super Polaris)* is expected to be combat ready by late 1964 or early 1965. All FBM submarines now under construction or in the engineering phase are being designed to handle both advanced models of the missile.

dvancing Asroc

With the *Advanced Asroc* now under development, the Navy expects to be able to strike enemy submarines at ranges well over eight miles. The key is GE's Mark 44 Mod 1 torpedo which will be the *AA's* payload. The standard *Asroc*, which went operational recently, packs GE's Mark 44.

est the Enemy See

New argument being pushed by the Navy to go ahead with seaborne satellite launch facilities: it would permit secret launchings and keep the U.S. from tipping its hand on the status of military hardware programs.

INDUSTRY

here the Missile Money Goes

The Air Force these days estimates that 80% of the total cost of its ICBM's is being spent on site activation. At the height of activation of a single launch site, costs can run to $100,000 to $200,000 per day—a particularly expensive item when there are slippage-causing work stoppages.

ERT Expands

Success of PERT (Program Evaluation Review Technique)—computerized management of *Polaris* R&D—is prompting the Navy to adopt it for all major new weapon programs.

rocurement Guidelines

The Air Force is currently beefing up its procurement regulations with a series of broad general guidelines for contractors. It also is warning AF personnel to avoid "imprudent social relationships" with contractors—including acceptance of gifts, entertainment or favors.

Flight Model Ion Engine

Look for NASA to award an R&D contract late in 1961 for a flight-model ion device with a 0.1 lb. thrust, using the SNAP-8 30-kw nuclear powerplant. Program will be based on Hughes' 0.01-lb.-thrust laboratory ion engine, which may be scaled up or clustered. First flight tests are to begin early in 1963, starting with battery-power aboard sounding rockets. First orbital flight with SNAP-8 power is programmed for 1965. This also may be the first flight of a ½-lb.-thrust plasma engine being developed for NASA under competing studies by GE and Avco.

Bigger 'Scope'

Kitt National Observatory, Tuscon, Ariz., is designing a 50-in. telescope for an advanced NASA orbiting Astronomical Observatory. It will be launched into a 24-hr. orbit, probably in 1966 by a *Saturn* vehicle. Prototype already has been built of the 10-ft.-diameter, 30-ft.-long telescope and is being groundtested for remote control, data reduction and telemetry techniques.

Nimbus Contract Slips

NASA's unexplained delay in awarding a prime contract for *Nimbus* is raising questions whether the advanced weather satellite will be launched as planned in early 1962. Some bids on subsystems (PCM telemetry and the tape recorder) already are in.

Apollo Speed-Up

COUNTDOWN hears pressures on Vice President Nixon's campaign may account for the timetable speed-up in the *Apollo* three-man spaceship. NASA was three weeks ahead of its self-imposed Nov. 14 deadline in awarding six-month, $250,000 feasibility study contracts. They went to Convair, Martin and GE last week, and cover system requirements, program plan, funding for a FY '62 R&D program.

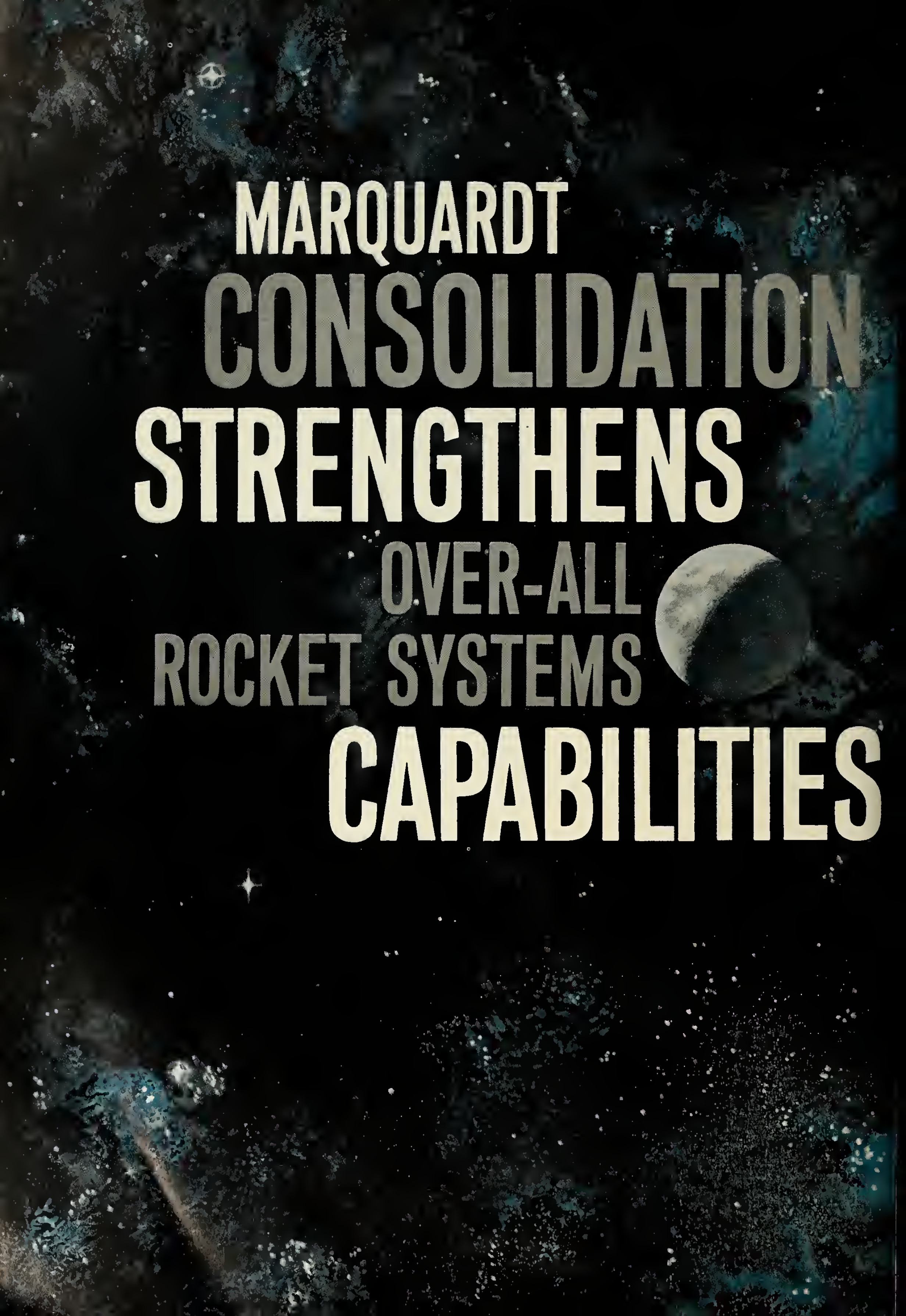
INTERNATIONAL

France's 5-year Defense Plan

De Gaulle's five-year defense program which squeezed through Parliament includes only $1.2 billion for nuclear "deterrent" weapons, which many French congressmen feel is insufficient. The total five-year defense "equipment" budget of $5.2 billion also includes: $154 million for missile R&D; $45 million for propulsion R&D; $45 million for test ranges; $10 million toward civilian space projects. No money was appropriated for a tactical ballistic missile. Estimated 10-year development cost of a strategic ballistic missile is $800 million, with tests beginning in 1963 and the first ones operational in 1968. Nuclear warhead development will proceed at $40 million to $60 million per year, bringing A-bombs into quantity production in 1968—and H-bombs not until 1970.

Overseas Pipeline

Russia is eyeing an astronomical observatory satellite . . . Key to Britain's space program may be the communications satellite package now being proposed by NASA for U.S. industry . . . Decision on an MRBM for Europe is not expected now until the mid-December NATO ministers conference.


MARQUARDT
CONSOLIDATION
STRENGTHENS
OVER-ALL
ROCKET SYSTEMS
CAPABILITIES

Cooper Development Division to Centralize Operations in Van Nuys

In the next few months the entire Cooper Development Division will move to the Van Nuys headquarters of The Marquardt Corporation. By concentrating aero/space operations in one centralized, fully equipped facility, the full capabilities of Cooper can be better focused on the technological problems facing government, industry, and private research groups.

Cooper Development Division will be in direct contact with extensive testing facilities and the combined experience and knowledge of the Power Systems Group and the ASTRO Division. Power Systems Group maintains an outstanding reputation in advanced rocket engine concepts, fuels and propellant research, high temperature materials development and experimentation, and advanced manufacturing techniques. A close working relation with the ASTRO Division will provide a nationally recognized source of basic and applied research information as it pertains to CDD's operations.

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Detailed information covering Cooper's experience, capabilities, products and services may be obtained by writing A. B. Metsger, Vice President-General Manager, Cooper Development Division, The Marquardt Corporation, 16555 Saticoy Street, Van Nuys, California.

Engineers and scientists experienced in aero/space activities are invited to acquaint themselves with the outstanding career opportunities in the field of rocketry at The Marquardt Corporation.

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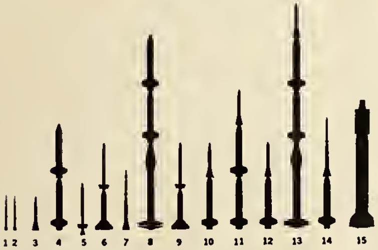

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Nixon: Military Has Mission

Vice President breaks silence in defense/space debate—replying to M/R's open letter, he contends Administration 'long ago' recognized strategic space race with Russia; sees 1970-71 lunar landing; opposes DOD reorganization

MISSILES AND ROCKETS submitted an open letter Sept. 27 to Vice President Nixon containing a nine-point proposal on defense and space. Following are Mr. Nixon's comments (M/R's proposals are in italics).

by Vice President Richard M. Nixon

1. Recognize as national policy that we are in a strategic space race with Russia.

If the Eisenhower Administration had not long ago recognized that we were in a strategic space race with Russia, our space record would not be as creditable as it is today.

Twenty-six earth satellites and 2 space probes have been launched successfully by the United States.

Six satellites and 2 space probes have been launched successfully by the Soviet Union.

Today 13 United States satellites are in orbit; only 1 Russian satellite remains in orbit.

Eight United States satellites in orbit are still transmitting; the sole Russian satellite in orbit is not transmitting.

The United States has recovered 2 satellite payloads from orbit while the USSR claims to have recovered one.

Despite the greater weight of USSR space vehicles, the United States has gathered far more scientific information from space. In instrumentation, communications, electronics, reliability, and guidance, United States space vehicles have made gigantic strides.

In short, the United States is not losing the space race or any other race with the Soviet Union. Today we are ahead of the USSR. From a standing start in 1953, we have forged ahead to overcome an 8-year Russian lead. And we will continue to maintain a clear cut lead in the race for space.

2. Expedite present space projects to provide a new and bold program with the following goals; Manned space platform—1965; A U.S. citizen on the moon—1967-68; Nuclear power for space exploration—1968-69; A space craft which can take off from earth, travel to and in space, return and land under its own power—1968-69.

The ability to exploit space is a first priority national objective of the United States. Inspiring goals have always been the choice of the American people. In the exploration of space our goals will be moved forward as rapidly as possible, taking immediate advantage of every technological breakthrough. We have a ten-year program, officially approved by the space agency and the President, targeted on realistic goals that can be achieved. It is bold and imaginative and as compatible with proposal no. 2 as informed technological projections will permit. Briefly, it provides for actual testing of a nuclear-fueled space engin Project *Rover*, by 1965. The program calls for launcl ing and operation of a permanent manned space st tion to which our astronauts will go and come an stage flights deeper into space in the period 1966-196 It provides for the first manned circumlunar fligh around the moon in the period 1967-68.

Because of the need to perfect the nuclear dee space engines and insure adequate power for retur and safe landing on earth, the moon landings a presently scheduled for the period 1970-71. It entirely possible that this target date will be advance

3. Recognize that "space for peaceful purposes" possible only if "freedom of space" is ensured; henc that the U.S. military must be given a predominan role in developing and carrying out the project necessary to guarantee freedom of space.

"Freedom of space," like "freedom of the seas," essential to the progress of mankind. The United Stat will promote the concept of "space for peaceful pu poses," and be its champion. Our efforts will b directed to ensure that we are fully supported b international agreement and law. As with our othe ideals and principles, our military forces must hav the mission, and the necessary strength, to defen "freedom of space."

4. Establish pre-eminent strategic, tactical and de fensive forces with representation from all service

President Eisenhower's 1958 reorganization of th Defense Department tightened civilian control over ou Armed Forces, firmed the authority of the Secretar of Defense, strengthened the staff serving the Joi Chiefs of Staff, cleared the command channels to ou fighting forces, and opened the way for expediting th decision-making process.

The execution of this plan has completely justifie and demonstrated the effectiveness of civilian contr and our present concept of organization.

I oppose the establishment of pre-eminent strategi tactical, and defensive forces with representation fro all services. My reasons, in part, are as follows:

1. Precise advantages of functional organizatio have not been identified and presented to the Congre and to the American people.

2. Today we have a proven defense system whic we are asked to abandon in favor of one havin obvious defects and no publicly known advantages.

3. The principles of functional organization an of the unified command are not new in any respec In fact, in our present defense organization, suc principles are used whenever they can be employe effectively.

Defend' Space

4. The proposal could lead to as many separate forces as there are military functions to be performed. Instead of an Army, Navy, and Air Force a multiplication of services could result accompanied by duplication, confusion, and increased costs without increased military capability.

I reject a "cannonball" approach and I reject the principle that just a little bit of reorganization will produce perfection in our defense organization. Improvements have been made over the years and will continue to be made after careful analysis, and with the approval of the Congress.

I believe that our present defense organization established by President Eisenhower should be retained for the present. Today our Armed Forces, subject to civilian control, are fully capable of an immediate and flexible response operating under an umbrella of invulnerable and diversified deterrent forces.

. Recognize the necessity of greater defense fund-ng to accomplish this, including a supplemental udget in January, 1961, to make it possible to: Speed p to a maximum degree the construction of ICBM aunching bases, Polaris submarines and the Mach 3 issile-carrying B-70. Provide the Army with funds o begin the immediate procurement of already-eveloped modern missiles, other weapons and airlift.

With respect to future defense budgets, the amount required must be determined on the basis of forces and programs and in context with the total national strategy. Military technology is moving at a very rapid pace and changes are occurring almost daily in the international situation. Clearly, under these circumstances, the defense program must be kept under virtually continuous review and changes made promptly wherever necessary. I have said many times I favor acceleration of the *Polaris* and *Minuteman* programs and I favor the speedy development of the B-70. Whether a supplemental appropriation will be necessary in January is a decision to be made at the time. If it usefully would serve our missile program, accelerated as recently as August and September by the President, I would favor it.

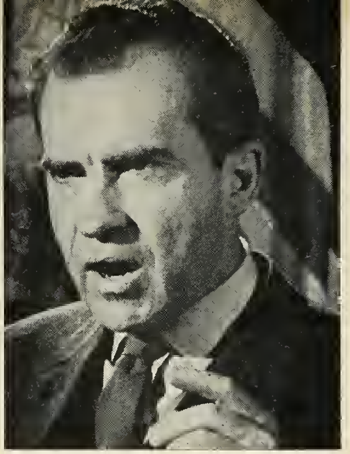
There cannot be and will not be a price ceiling on our security. The United States must, and I for one am resolved, to pay what is necessary in money and effort to provide for our common defense.

This is my position and I state it positively—we can afford and we will provide the defense America needs. There can never be a price ceiling on security, nor will we flinch from the demands our security requires.

Establish further-on defense spending by need and ot by budget ceiling.

In answer to this question I should like to quote from the Republican Party Platform of 1960:

The United States can and must provide whatever is necessary to insure its own security and that of the free world and to provide any necessary increased expenditures to meet new situations, to guarantee the opportunity to fulfill the hopes of men of good will everywhere. To provide more would be wasteful. To provide less would be catastrophic. Our defense posture must remain steadfast, confident, and superior to all potential foes.



"I oppose establishment of pre-eminent strategic, tactical and defensive forces with representation from all services."

7. Streamline defense regulations and procedures to make industry's role in the U.S. defense and space effort more effective.

Defense regulations and procedures have improved steadily throughout the years of the Eisenhower Administration.

Of America's annual 40-plus-billion-dollar defense budget, approximately 25 billion dollars is spent each year in contracts for equipment, material and services including research and development of weapons systems.

Now, the 25 billion defense dollars spent in industry contracts is three times the combined purchasing volume of General Electric, General Motors, and United States Steel.

Obviously, in a business as large as that conducted by the Defense Department, improvements can be made. And improvements have been made and will continue to be made. As an example, the Single Manager System installed in 1956 to eliminate duplication among the military services in the procurement of common-use supplies has produced almost 400 million dollars in factual savings over the last four years.

8. Take what steps may be necessary to establish and promote national scientific objectives.

National scientific objectives have been established and are being pursued vigorously. Technological breakthroughs are exploited to the maximum advantage. From a standing start in 1953, the United States has had to telescope time in our scientific efforts. Our scientists and engineers have worked wonders, and are highly deserving of the deep gratitude of this nation. I can assure my fellow Americans that we will all continue to press forward to attain and even surpass our national scientific objectives.

9. Re-establish decision-making in the U.S. defense and space organizations.

It may be that further improvement in the decision-making process will be found necessary in the future. I will not hesitate to recommend to the Congress any additional improvements required in the national interest. At the same time, I can not condone any changes incompatible with our fundamental principles of government. ⌘

Turn page for comparison of Nixon's stand with Sen. Kennedy's answer in M/R Oct. 10.

Candidates' Views Compared:

Senator Kennedy

1. We are in a strategic space race with the Russians and we have been losing.

2. Target dates for a manned space platform, man on the moon, nuclear power for space exploration and a true manned space ship should be elastic. All should be accomplished as swiftly as possible.

3. Freedom of space must be assured, preferably by mandate of the United Nations. The United States must have pre-eminence in security as an umbrella under which we can explore and develop space for the benefit of all mankind.

4. We must reorganize the "cumbersome, antique and creaking machinery of the Department of Defense. The Democratic Platform calls for reorganization according to functions and missions. We will study the feasibility and efficiency of a (combined) Strategic Command, Tactical Command, Continental Defense Command, Material Command and Development Command."

5. "In January I will send to the Congress specific requests to: accelerate *Polaris, Minuteman* and other strategic missile programs; expand and modernize our conventional forces; harden and disperse bases; use an air alert; do more on antisubmarine warfare; speed up development of space warning systems and an anti-missile weapons system."

6. "Defense spending must be based on the security needs of the nation and not the predetermined confines of a budget. Basic research must be encouraged and expanded on a long-range budget plan. Research cannot be started and stopped according to the whims of the budgeteer."

7. "Certainly defense regulations and procedures must be simplified and the proliferation (in the Department of Defense) of secretaries, assistant secretaries, under-secretaries, special assistants and deputy assistants to secretaries, boards, commissions, councils and committees must be rolled back."

8. "National scientific goals will be our first objectives, continuously emphasized."

9. (On decision-making) ''The Democratic Party has strength in depth among dedicated men familiar with defense problems. They will have a mandate to speed the decision-making process, and authority to make affirmative decisions very quickly."

Vice President Nixon

1. The Eisenhower Administration long ago recognized we were in a strategic space race with Russia. Today we are ahead.

2. The ability to exploit space is the first priority national objective. The Administration's 10-year program calls for testing a nuclear-fueled space engine by 1965; a permanently manned space station by 1966-67; circumlunar flights in 1967-68; moon landings 1970-71.

3. "Freedom of space," like "freedom of the seas," is essential to the progress of mankind. Our military forces must have the mission and the necessary strength to defend "freedom of space."

4. "I oppose the establishment of pre-eminent strategic, tactical, and defensive forces with representation from all services." Among the reasons: It could lead to as many separate forces as there are military functions to be performed . . . "I believe that our present defense organization established by President Eisenhower should be retained for the present."

5. "I favor acceleration of the *Polaris* and *Minuteman* programs and the speedy development of the B-70. Whether a supplemental appropriation will be necessary in January is a decision to be made at the time. If it would usefully serve our missile program, I would favor it."

6. The United States can and must provide whatever is necessary to insure its own security. To provide more would be wasteful. To provide less would be catastrophic. There should never be a price ceiling on security.

7. "Defense regulations and procedures have improved steadily throughout the years of the Eisenhower Administration. Obviously, in a business as large as that conducted by the Defense Department, improvements can and will continue to be made."

8. "National scientific objectives have been established and are being pursued vigorously. Technological breakthroughs are exploited to the maximum advantage. I can assure my fellow Americans that we will all continue to press forward to attain and even surpass our national scientific objectives."

9. "It may be that further improvement in the decision-making process will be found necessary in the future. I will not hesitate to recommend to the Congress any additional improvements required in the national interest. At the same time, I cannot condone any changes incompatible with our fundamental principles of government."

Countdown for Survival

M/R readers continue to debate th defense/space issues raised in the Oct. . edition. A few of their comments:

Define 'Space Race'

Isn't it time we defined the term "Spac Race?" Before readers can have educate views on "winning the strategic space rac with Russia" they should have a clear-cu understanding as to the objectives of th race.

In actuality, it would require actio at the top levels of our government an State Department to properly define th "Space Race." And I believe it is tim that this should be done.

Why not set forth—for the world t know—(a) Just what we consider to b productive efforts in this field and, there fore, ones in which we will be very active and (b) Efforts we consider to be a wast of time, money, men and materials, an therefore efforts in which we will d nothing. For example, in category (a) w could include all space programs whic promise concrete advantages, such as sa ellites for navigation, surveillance, weathe observations, communication and tel vision relays, "man in space" effor related only to space adjacent to our ow planet, rockets for mail and other tran portation and the like. In category (b let's publish as official that we do n intend to put a man on the moon— any other planet. What purpose is the in such devastatingly expensive efforts?

'Most Powerful'—Ike

President Eisenhower struck out at critics of the U.S. strength during a nationwide "non-political" speaking tour.

"If we look out today at ourselves in true perspective we see a great nation," the President said in his concluding address at Houston. "The most powerful the world has seen . . ."

He said the United States has no need for "giant new arms programs." He said the nation already is "pursuing defense policies and programs which provide us with real security now, and if our nation remains alert and flexible in meeting changes in the world situation will do so into the future."

Defense Secretary Thomas Gates said in a speech in Miami the following day that U.S. military strength is "the greatest the world has ever known."

"I would resign my position as Secretary of Defense this moment if I had any reason to believe that our national policies were building a second rate defense," Gates said.

(Continued on page 46)

A-Test Ban Hurts Missile Warheads

AEC's Wilson leads in warning that Reds may be testing; Polaris, Minuteman are affected

by James Baar

FAILURE of the United States to sume nuclear testing and its possibly oding effect on U.S. missile power is .using increasing alarm in military rcles.

The reason is the growing belief nong top government officials that e Russians are conducting secret nderground nuclear tests.

AEC and military officials warn that this is so, and the United States does ot follow suit, the Russians can gain a emendous advantage in developing im- oved nuclear warheads for both ctical and strategic missiles.

Particularly at stake is the chance develop much more powerful war- ads for *Polaris* and *Minuteman.*

Today all nuclear-tipped U.S. ssiles carry warheads tested prior to ov. 1, 1958—the beginning of the f-imposed U.S. suspension of nuclear ting that matched a moratorium de- red by Russia. In effect, the U.S. oratorium froze the payloads for ich missiles are designed.

New tests, all of which would be derground to prevent fallout, could begun very quickly. The AEC has rked throughout the moratorium iod on the improvement and ex- nsion of elaborate facilities for under- und testing at its Nevada Test Site.

The first underground test—*Rainier* ook place there in 1957. Other tests owed under the Nevada mesa.

• **Soviet cheating?**—Both presiden- candidates in their fourth TV de- e underlined the possible danger of tinuing indefinitely the so far fruit- negotiations with the Russians for nuclear test ban based on a satis- tory system of policing it.

Sen. John F. Kennedy said whoever lected President should make one effort to reach an agreement with sia on a test ban. But he said if the rt fails "we'll have to meet our onsibilities to the security of the ted States."

Vice President Richard M. Nixon believes the Soviets are "actually filibustering" the test ban negotiations and that "it's time for them to fish or cut bait." He said a last effort at agreement should be made immediately after the presidential election.

"I don't think we can wait until the next President is inaugurated," he said, and added omniously that based on reports he has concluded the Russians already "may be cheating."

Dr. Robert E. Wilson, an AEC commissioner, was more specific. In an Oct. 20 address in Chicago, Wilson said:

"There have been recent indications of some explosions in Russia which they have tried to explain as unusually large shots of conventional high explosives.

"No explanation has been offered," he added pointedly, "with regard to their claim last winter of having just developed an amazing new weapon. If that was a nuclear weapon, as seems probable, how could they know it was amazing unless they had tested it? Or, if they are turning out missiles like sausages, as Mr. Khrushchev told the United Nations, dare we assume that these are either of old or of untested designs?"

• **Key to power**—Wilson, a former board chairman of Standard Oil of Indiana and a noted engineer, also put in some of the plainest terms so far the military gains to be achieved by resuming nuclear testing:

—"New and really revolutionary types of nuclear weapons might be developed by the underground testing of relatively small weapons. This is especially true in the small 'battlefield' devices designed to put troops out of action quickly and effectively with a minimum of people at a distance. In addition, however, valuable information regarding much larger weapons can also be obtained by small underground weapons tests which would be free from any possibility of fallout.

—"Designs of nuclear weapons really tailored to recent and prospective new defense systems could be developed and their dependability and safety, which must necessarily be demanded of all nuclear weapons stockpiled, could be reliably checked.

—"It would be possible to increase substantially the yield-weight ratio of a considerable number of our older bombs and warheads using this advantage either to increase the yield for a given weight, or decrease the weight for a given yield, both of which would have great military value, especially in long-range missiles such as the *Minuteman* and *Polaris.*

—"It would be possible to make further progress on getting greater cleanliness—less radiation hazard—in weapons of various sizes and it might even be possible to produce thermonuclear weapons without any fissionable products, as some of our scientists have envisioned."

Wilson said that these foreseeable improvements are of such importance that "any country which decides to proceed with further testing . . . while we continue to observe a moratorium is likely in a few years to take our place as the foremost nuclear power in the world."

Moreover, Wilson clearly indicated he thought this was exactly the course on which the Russians have already embarked.

"We know of no practical way at present to detect and identify underground tests inside Russia up to 20 kilotons of TNT equivalent or well over 100 kilotons if they are muffled," he said.

"In view of the Soviets' record of open breaches of solemn agreements and promises during the past 15 years . . . it is beyond my comprehension why so many well-meaning people urge blind reliance on their record in this area where incentives for breaking it are so large and there is virtually no chance for detection."

It is understood that other members of the AEC saw Wilson's statements and generally concurred. ⌘

The Missile/Space Week

Bambi, Saint and Spad—Satellites Beware

The Air Force is expected to award a contract by mid-November on *Saint*—A system for inspecting and intercepting enemy military satellites.

Some two dozen companies are understood to be involved in the bidding that closed at the end of October. The Air Force is reported to be planning the first test launching within a year.

Meantime, ARPA is moving ahead with its *Bambi* studies for a satellite capable of launching anti-missile missiles against ICBM's seconds after they are launched. A competition for more studies is possible soon.

Convair's *Spad* is a principal entrant in the field. *Spad* is a study aimed at development of a satellite that would provide early warning of a launching and either alert ground-based anti-missile missiles or launch one itself.

Red Rocket Sub Raises Few Eyebrows

Informed Navy sources are attaching nothing new to Soviet premier Nikita Khrushchev's recent boast that Russia has submarines "equipped with atomic engines and armed with rockets."

The Navy has said for some time that the Russians were apparently building several nuclear-powered submarines. It also has said that Soviet diesel-powered "Z" Class submarines carried missiles with a range of several hundred miles. These missiles are launched from the surface.

Navy sources said Soviet missiles carried by a nuclear-powered submarine apparently are of the same type.

IUE Chief Carey Undercut by GE Settlement

Settlement of the nationwide IUE strike against 54 General Electric plants appeared this last week to have weakened the authority of IUE President James Carey.

More than 50,000 IUE members returned to their jobs after the three-week strike concluded in the signing of a contract almost identical to the original proposal offered by GE. The contract provided an initial 3% pay boost.

The settlement came after IUE negotiators and Westinghouse signed a generally similar agreement.

The strike against GE suffered from unpopularity among powerful elements of the IUE—particularly Schenectady Local 301, the union's largest. Carey blamed the strike's lack of gains on Local 301's "desertion."

Top Red General Takes Command of Soviet Missiles

The Russians have again reminded the world of the importance of the all-inclusive Soviet Rocket Command.

The reminder came with the announcement that Marshal Mitrofan I. Nedelin, chief of the Soviet Rocket Command and Deputy Defense Minister, had been killed in a plane crash Oct. 24. Moscow radio said Nedelin has been succeeded in both posts by Marshal Kirill Moskalenko.

Marshal Moskalenko is the former commander of the vital Moscow Garrison and a member of the Central Committee of the Communist Party.

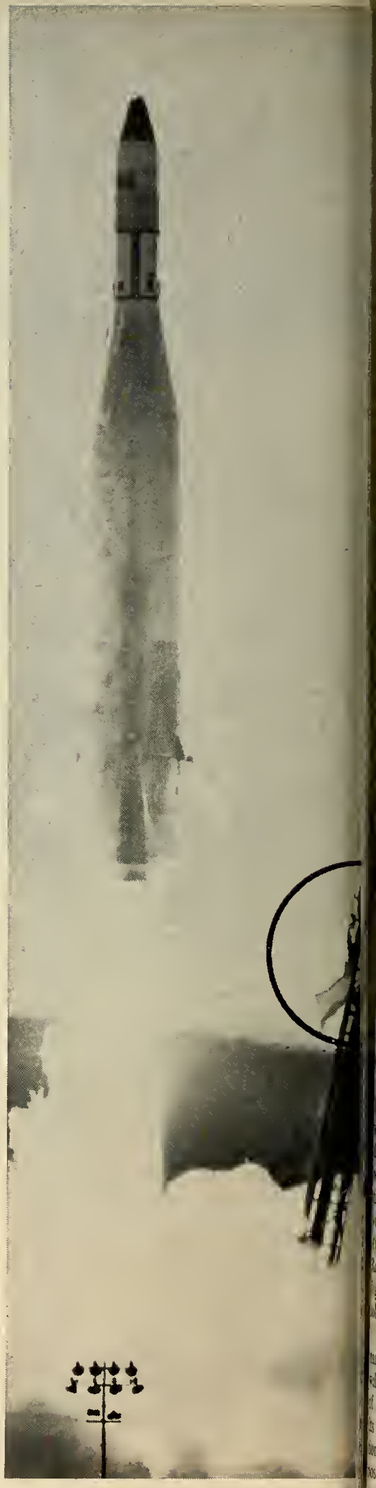
Space Guidance for the Confused

The Defense Department's Office of Public Service is seeking to perform the laudable public service of unconfusing the public about space—now that election time has come again.

In a clearly non-partisan memorandum to all "Department of Defense speakers," Public Services Director James Dunton said "some Americans have the false idea that we are behind the Soviets" in space.

Therefore, Dunton provided a "Score Sheet" on space listing all successful U.S. and Soviet space launchings in small type. In big type, the sheet noted that the "Total Achievements—U.S. vs. U.S.S.R. were 25 U.S. satellites to Russia's six and two space probes each.

Dunton recommended that speakers use the "Score Sheet" to "correct misconceptions." He neglected to suggest any discussion of the relative significance of U.S. and Soviet launchings.



Bad Disconnection

FAULTY umbilical disconnect (see circl
caused failure of Atlas-Agena vehicle
orbit the Samos reconnaissance satelli
from Pt. Arguello Oct. 11.

JPL Space Probing Hits $50 Million

1961 industry share of 65% apt to be hiked next year; planetary fly-bys with Mariner and Voyager vehicle due in 1962-3

by William J. Coughlin

PASADENA, CALIF.—The surface of cloud-shrouded Venus is to be mapped by radar from an orbiting vehicle within five years as part of NASA's interplanetary exploration program. Mars will be mapped photographically at about the same time.

These were among details of NASA lunar and planetary programs outlined here last week by Jet Propulsion Laboratories for some 600 industry representatives. It was the last of three briefings held at NASA centers following the first NASA-Industry Program Plans Conference in Washington (M/R, Aug. 8, p. 17). Earlier briefings were held at Goddard Space Flight Center (M/R, Sept. 5, p. 13), and George C. Marshall Space Flight Center (M/R, Oct. 3, p. 13).

Dr. William H. Pickering, director of JPL, said the laboratory will spend approximately $50 million this fiscal year on the NASA programs. Of this, 65% will go to industry, with that proportion probably increasing next year.

"As a matter of fact, it is our plan that the lunar program in particular, which represents about 50% of our total fiscal year 1961 budget, will be carried out predominantly through industrial effort," Pickering said.

• One-ton Surveyor—There were few details of space vehicles and their experiments.

The *Surveyor* spacecraft which will ollow the *Ranger* lunar impact vehicle will weigh approximately one ton, including guidance and retro systems, and be able to soft-land 100 pounds of instruments on the moon. Launch vehicle will be an *Atlas Centaur* similar to the *Atlas Agena B* combination used in the *Ranger* program—which calls for five flights, including three lunar impacts, a olar satellite and an earth satellite.

The *Saturn*-boosted *Prospector* lunar craft which will follow surveyor will be capable of accelerating payloads of several tons to lunar transfer speeds. ts missions will include roving exploration of the moon's surface and the possible return of lunar material amples to earth.

Physical properties of the moon to be measured include surface texture nd hardness; thermal properties (temperature, temperature gradients, and thermal conductivity); density; electrical parameters such as conductivity and permeability; the nature and magnitude of the moon's magnetic field, if any; a determination of the level of seismic activities. Geophysical methods, such as seismometry and gravimetry, will be employed to determine the internal structure of the moon.

Whatever lunar atmosphere exists also will be analyzed. Organic molecules will be isolated and analyzed in the search for pre-life and sub-life forms.

• Search for life—Fundamental scientific knowledge sought in NASA's space exploration program is aimed at answering three questions:

–Is there extraterrestrial life?

–What can be learned of the origin and evolution of the solar system and its component bodies?

–What must be learned to assure the success of the more difficult missions of the future?

NASA now hopes by 1970 to have spacecraft capable of landing on the surfaces of Venus and Mars, as well as probing out to Jupiter and Mercury. JPL interplanetary craft using the *Centaur* launch vehicle will be called *Mariner* and those using the *Saturn* booster will be called *Voyager*. These plans for interplanetary explorations were outlined:

–First *Mariner* mission will be a fly-by of Venus in 1962 to provide scientific measurements of the planet and developmental test of the spacecraft and its instruments. After a second *Mariner* mission as a deep space in 1962, the *Mariner* will be used with some refinements and instrument changes for Venus probes in 1964 and possibly 1965.

Developmental missions to Venus using *Voyager* will begin in 1965. The first *Voyager* will be an extension of the *Mariner*, with the additional injected weight available being used primarily for a retro-propulsion and terminal guidance system to put the spacecraft in orbit around the target planet. It is planned to include an active radar in the Venus orbiter for mapping the surface.

• Planet exploration—First launching of the *Mariner* Mars spacecraft is scheduled for 1963 as a developmental mission and will be a prototype for the 1964 Mars mission. Trajectory will be chosen to provide the best overall test of the spacecraft involving some form of earth return orbit. First flight of a Mars orbiter *(Voyager)* will place emphasis on surface photography.

Direct observation and identification of life forms now living on the surface of Mars is regarded as a most important experiment, requiring a landing. This spacecraft will carry TV reading microscopes working in the ultraviolet and near ultraviolet regions, as well as systems for culturing mirco-organisms and measuring the changes in the culture medium. Dates for Mars surface exploration were not given.

Increased capability of the *Saturn* C-2 vehicle is expected to permit a Mercury fly-by in 1970. Early shots aimed toward this planet probably will be devoted to photographing the planet's surface and permitting, by observation of the spacecraft trajectory, better determination of the planet mass and mass distribution. Experiments will be designed on the basis that Mercury probably is very much like the moon.

Initial effort at probing Jupiter is to be made by 1970, again utilizing *Saturn* C-2 and possibly a nuclear upper stage. Jupiter is assumed to have a large and intense Van Allen radiation belt, and therefore, a strong magnetic field. Measurements of the detailed nature of these features will be made by the first Jupiter spacecraft with a complete spectrum of field and particle measuring devices.

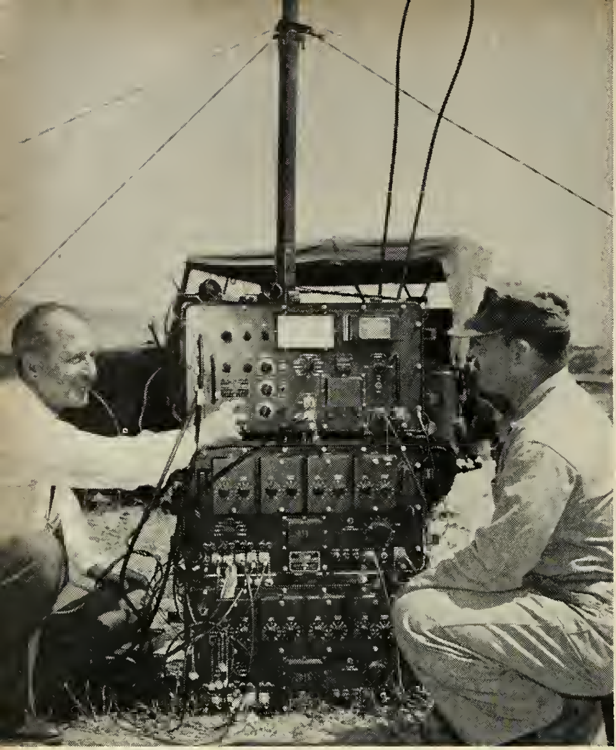
An attempt to probe interplanetary space out of the plane of the ecliptic is planned in 1968, again using *Saturn* C-2.

JPL Contracting Schedule

The *Surveyor* moon vehicle hardware contract will be let probably in February. Present holders of vehicle design study contracts include Hughes, North American, STL and McDonnell.

About 25 firms are being invited to bid on *Prospector* study contracts —with four awards of $250,000 each due to be made next spring. A hardware contract will be let in FY '62.

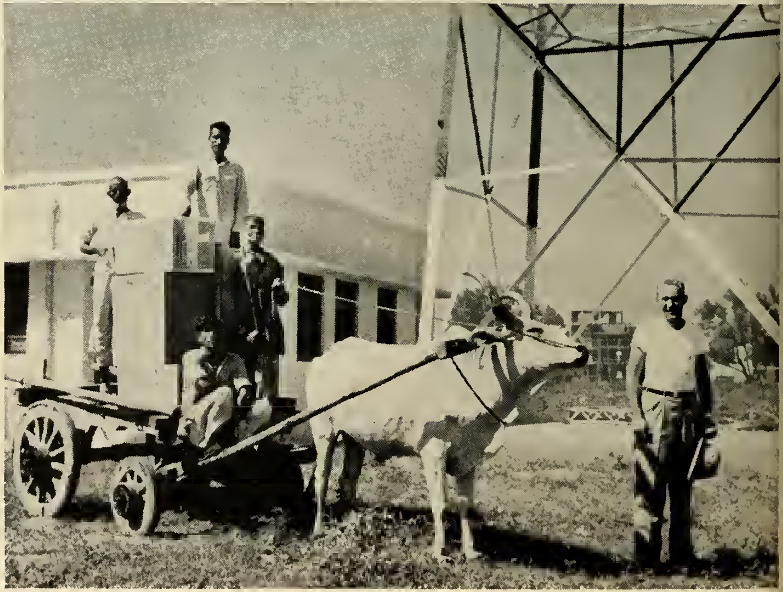
Awards are due before the end of 1960 on $100,000 study contracts for 250-ft. antennas to upgrade JPL's Goldstone facility in support of the space exploration program. Several lesser contracts are scheduled to be let by JPL in the remainder of FY '61.



In Germany, checking a proposed radar site for masking objects, preparatory to installation.

Instructing Marine Corps personnel in portable microwave communications equipment, AN/TRC-27.

Delivering AN/CPS-9 weather radar parts for the Department of Meteorology, New Delhi, India.

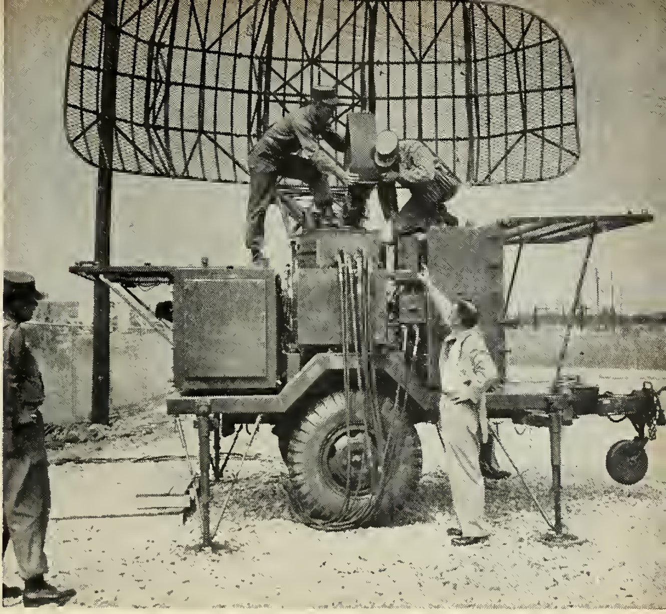


Now in their 18th year of technical assistance

Raytheon field engineers, in over

work on installation, instruction and maintenance

On-the-spot training in the field on part of the Hawk missile system.



About to board a B-47, this Raytheon field engineer provides technical assistance on electronic countermeasures equipment.

(U.S. Navy photo)

On Midway, Navy technicians receive instructions on adjustment of airborne navigational equipment.

Armed Services and government agencies,

tions in the United States and overseas,

tronic equipment. RAYTHEON COMPANY, WALTHAM, MASS. RAYTHEON

EXCELLENCE IN ELECTRONICS

With its third consecutive satellite success, RCA Astro-Electronics Division has made "reliability" meaningful in space systems engineering and development. Read the "Reliability Record" for yourself.

December, 1958: Project SCORE. AED developed the communications and control systems for the U.S. Army Signal Corps' "Talking Atlas", part of a program under ARPA, Dept. of Defense. Transmitters, receivers and control units in the satellite and at the ground stations all operated perfectly as the "Talking Atlas" broadcast the President's Christmas message and proved the feasibility of active communications satellites.

April, 1960: TIROS I. The sophisticated satellite, including its structural design as well as the electronic systems, and its ground stations were developed and built for NASA by AED under the technical direction of the U.S. Army Signal Corps. It accomplished its mission in meteorological observation, sending down over 20,000 TV pictures of earth and its cloud cover.

August, 1960: Project ECHO. The only electronic equipment on this 100-foot balloon, launched by NASA to prove the feasibility of passive communications satellites, are two "dinner plate" beacon transmitters 10 inches across by ⅜ inch thick, including storage batteries and solar cells. These units, designed to permit beacon tracking of the satellite, weigh only 11 ounces apiece and were developed and built by AED.

As more and more sophisticated space systems are developed, AED will continue to design for reliability in this most demanding of all environments. To find out how you can draw on this dependable R&D capability, contact the Manager, Marketing, RCA Astro-Electronics Division. If you are interested in participating in this challenging team effort, contact the Employment Manager, Astro-Electronics Division, Defense Electronics Products, at RCA's "Space Center" in Princeton, N. J.

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THE MISSILE/SPACE WEEKLY

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Technical Countdown

ELECTRONICS

adiation Effects Lessened

New high-frequency, thin-base transistors are less sus-eptible to radiation damage than older types, says IBM in a eport on its recent study. Next most seriously affected com-onents are capacitors.

ore on Escalator Cooling

Rocketdyne has designed a moving belt radiator for ooling nuclear-powered space vehicles. Running the belt t different rates makes it possible to control the rate of heat oss. The belt runs through the engine, picking up heat at he surface of the reactor core and carrying it outside.

roject Sherwood Spawns Ion Gage

A photomultiplier ion gage, linear with pressure from 0^{-3} to 10^{-10} mm Hg, has been perfected by Westinghouse ngineers as part of a long-range AEC-sponsored research rogram aimed at controlled nuclear fusion. The gage does way with the usual heated filament and employs a beam f ultraviolet light.

iquid Flywheel For Satellite Stabilization

General Electric is reported to be making progress on he concept of a "liquid flywheel" for satellite attitude con-rol. Liquid metal (such as mercury or sodium) is mag-etically pumped around a closed loop at high speed to rovide the same stabilization effect as a conventional hard-etal flywheel.

ASW ENGINEERING

dvanced Sonar Tests Start in Spring

If progress continues at its present rate the Navy will st its new 70-mile-range sonar next spring. Only a few eeks ago the Navy ordered production to start on its 12-ile-range sonar system. Both accomplishments have been hieved during the past year following a step-up in ASW &D.

ADVANCED MATERIALS

reaty of the Meter Superseded

It was hardly noticed but the world officially replaced e standard meter bar resting in Paris with the orange-d line of krypton 86 as the new standard of length. The .S. inch must now be equal to 41,929.399 wavelengths the krypton light.

flated Re-entry Gliders Feasible

NASA has concluded that inflatable re-entry vehicles e possible and offer some advantages such as foldability d low landing speeds. One typical configuration would ve a wing load of 1.5 lbs./sq. ft. and could operate within angle-of-attack range from 11° to 66° and at initial -entry angles from 0° to –2.5°.

diation-Resistant Rubbers Developed

Researchers at B. F. Goodrich have created 14 new bber-like materials which are now being evaluated for diation resistance. The study expects to show how the ation of an aromatic group in a polymer affects the de-e of radiation protection.

GROUND SUPPORT EQUIPMENT

"Measurement Pinch" Tightens

Several instances of just how far the state of the art of precise measurement is being pushed have been revealed at recent Bureau of Standards measurement research meetings. Manufacturers accept jobs with "impossible" tolerances, reluctant to admit that equipment and techniques for the necessary measurements do not exist—and then search frantically for some way to do the job. One company, it was learned, built some ultra-precise equipment but was unable to check it against the specifications. When the units were accepted by the buying service, the manufacturer tried to find out how they were inspected for tolerance and learned that the buyer couldn't check them either.

Solar Test Facility Started

General Electric has begun construction of a facility to test large solar-powered static generating systems for space. The facility, located near Phoenix, Ariz., will be able to handle solar collectors as large as 21 feet in diameter on a movable sun-oriented mount.

Expanded Standing Still

Newly acquired data published by ARDC effectively increased the maximum altitude rating of Republic Aviation's new space simulation chamber from about 800,000 to more than 1,000,000 feet. The chamber's pressure capability of 10^{-8} mm Hg remained the same, however.

Electronic Pump Produces Ultra-High Vacuums

Vacuums well past 10^{-9} mm Hg are said to be obtainable with Varian's new VacIon electronic pumps. The pump, with no moving parts, operates by electronically removing gas molecules and atoms from circulation by the formation of chemically stable compounds and by "ion burial."

OPTICS

Super-Precise Camera Developed

A resolution capability of 50,000 lines per inch has been achieved by a research camera developed by the National Bureau of Standards. The camera will be used in efforts to set up standard methods for determining the resolving power of photographic materials. No such standard exists at present.

Bigger Telescope for OAO

A 50-in. telescope is planned for later versions of the NASA Orbiting Astronomical Observatory, replacing the 36-inch unit programed for the first two satellite observatories. The bigger telescope would enable researches to measure the red shift of Lyman-alpha emissions from galaxies farther than the two-billion-light-year range of the 200-inch Palomar optical telescope.

PROPULSION

Polaris Propellant I_{sp} 245-250 seconds

It's now declassified: I_{sp} of the present 1200-mile *Polaris* propellant (ammonium perchlorate-aluminum polyurethane combination) is 92-94% of the theoretical limit of 266 seconds.

Astronauts Get 'Final' Space Suits

Latest version incorporating 120 modifications of original design gives much greater freedom of movement, safer instrumentation

STRAPPED, VISORED AND ZIPPERED Astronaut "Deke" Slayton emerges from centrifuge chamber after a rigorous test of the new suit. In case of a cabin decompression, the orbiting astronaut could not live more than 10 seconds without the suit.

by Heather M. David

THE FINAL DESIGN of the *Mercury* pressure suit has been streamlined to allow the astronaut greater movement—from bending his knees to gulping his Adam's apple.

The new suit incorporates some 120 modifications of the original model designed by the National Aeronautics and Space Administration's Space Task Group and manufactured by B. F. Goodrich. It was pronounced flight-ready after weightlessness tests in a KC-135 transport at Wright-Patterson AFB, Dayton. The astronauts got the new suits from Akron last month.

Barring further drastic complications, this suit will go on the first manned *Redstone* flight—scheduled for early 1961—through the orbital mission. All seven astronauts rigorously tested the new suits in the *Redstone* mission profile on the Navy's Aviation Medical Acceleration Laboratory centrifuge at Johnsville, Pa.

• **Design lampooned**—Throughout the program much criticism had been leveled at the suit design, which under full pressure permitted little maneuverability by the pilot. The addition of reinforcing strips at the knees, shoulder and small of the back has helped by creating extra bending points.

The astronauts are satisfied. Navy Lt. Comm. Walter Shirra, who specialized on the suit part of the program, maintains "The suit is adequate for what we want it to do."

"It's not designed to walk around the moon or change vehicles in space or put patches on rocket ships . . . The requirements of the *Mercury* capsule are such that we are in a couch or use part of the couch to protect us."

Five "ribs," or convolutions, at the shoulders, elbows and knees allow bending movement of almost 90°. NASA spokesmen admitted that bearings at the joints would allow easier movement but the danger of pressure leakage would be greater.

The hands, a trouble-spot since de-gn first began, have shaped up with but one finger curved with ribbed aterial to follow the natural con-uration.

After much experimentation, the ace Task Force found that the astro-ut needed one finger he could aighten without too much effort to sh control buttons. The left middle ger has been designed to remain aight under pressurization for this rpose.

• **Medical instrumentation moved**

In testing one of the older suits the ace Task Force found that there was great danger of disconnecting the edical telemetering system attached the astronaut's waist.

The biopatch was moved to a less lnerable spot on the right thigh, where e wiring does not interfere with body ovement or the oxygen connection. addition, the telemetering system was anged from a 16-connection maze of ring to a single, round cannon-plug nnection with 20 possible inputs.

Through this one attachment, tem-rature, respiration and four EKG's ectrocardiograms) will be transmitted. e EKG's will be sensed by two elec-des strapped on the chest and one der each arm.

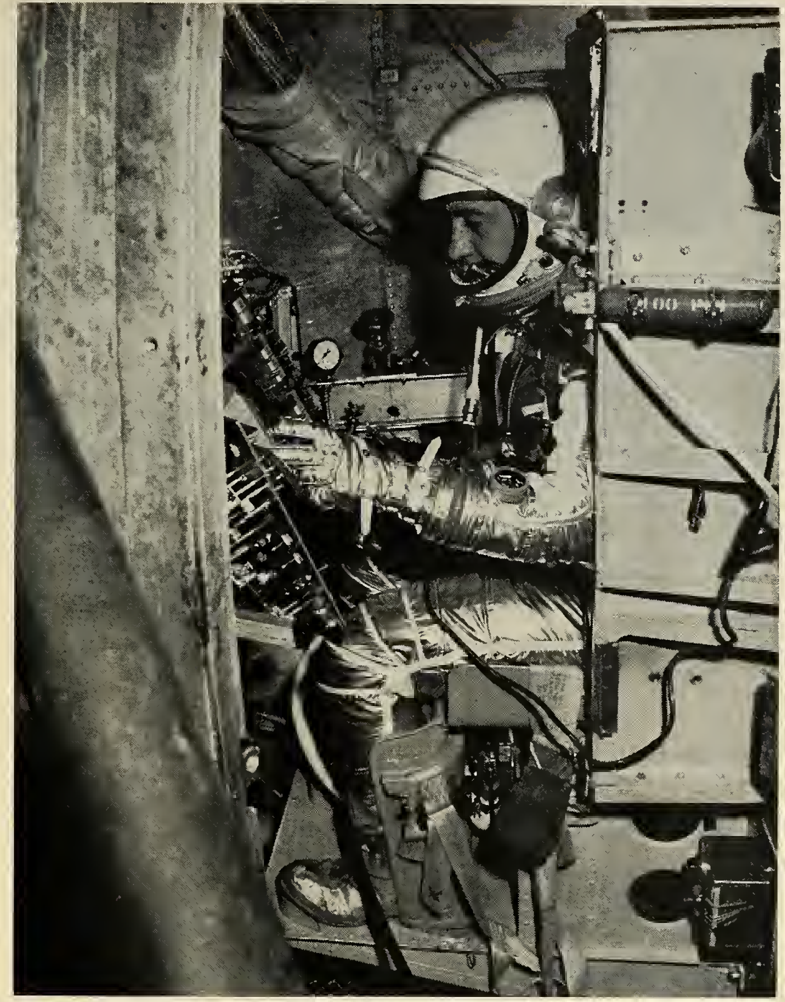
Other monitors have not yet been nounced. No answer to the problem taking blood pressure has yet been und, according to NASA officials. ice a pressure cuff must be used to se blood pressure, it becomes a diffi-lt and cumbersome task in flight.

The oxygen umbilical cord remains the waist where it disseminates 100% throughout the suit to cool it be-e circulating into the helmet. A con-ction at the helmet purges the system exhaled CO_2.

Odors removed from the suit are ssed over an activated charcoal bed. vo beds of lithium hydroxide remove e CO_2. The oxygen supply will last hours, but the lithium hydroxide ll be expended in 36 hours.

• **Air-conditioned**—Although air nperatures may reach 125° or more ring re-entry, the suit can be easily ntrolled to a comfortable 80°. In a ent *Big Joe* booster shot the *Mercury* psule went to 150° air temperature d 225° wall temperature—still no ad on the heat exchanger system. A onge rubber inner layer which had en designed to insulate against heat s discarded at this time.

Water condensed from the air is ught in a vinyl sponge and squeezed o a container. The water is a coolant r both suit and cabin and can be ed as an emergency drinking supply ile the astronaut is waiting to be ked up.



ASTRONAUT Virgil I. Grissom takes simulated flight in new pressure suit on centrifuge at Johnsville. Note straps at wrist and knees to prevent suit from dangerous "ballooning." New pressure gauge on arm provides backup for cabin equipment.

During normal flight cabin pressure will range from 5.1 psi to 5.5 psi. The suit will always contain a little under a pound pressure because of the oxygen-cooling and respiratory system.

• **Emergency**—The astronaut will have two pressure gauges to warn of cabin decompression. Besides the cabin instrumentation a small pressure gauge has been added to the forearm of the suit to provide backup.

If either gauge shows too much pressure loss, the reading will trigger pressurization of the suit. The *Mercury* suit will go to about 4.6—but it can withstand four times this much pressure before bursting.

Weighing a total of 20 lbs. with helmet and shoes, the suit actually has two separate layers. The exterior layer is covered by an aluminized nylon coating provided by Minnesota Mining and Manufacturing, which is plied to the Goodrich rubber suit layer.

The suit has a total of nine zippers—two at each ankle, two attaching the gloves, three on the torso and two "Slayton" zippers on the neck. The neck zippers got this distinctive appellation when astronaut "Deke" Slayton's Adam's apple tangled with the original single center zipper.

• **Noise protection**—the 4½-pound helmet, which will be closed during launch, re-entry and most of the trip, also serves as protection against the noise of the *Atlas* booster. Outside the capsule the noise has been measured at 145 decibels inside, 115. The helmet eliminates an additional 15-20 db.

The helmet, made of hard fiberglass, has a 1½-inch-thick layer of pyrofoam material called Lockfoam, manufactured by NOPCO. The shock-absorbent material gives slowly to prevent the astronaut's head from bouncing around in his own helmet. ⌘

Thermoelectric Modules Have Arrived

Developments at Diamond Ordnance have brought the devices to readiness for work in missiles and space

by William Beller

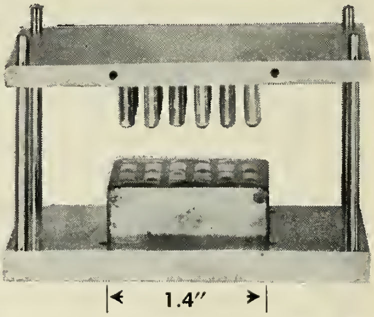
THERMOELECTRIC MODULES for electronic cooling and heating are finally here. They are ready to be designed directly into equipment.

The applications are impressive. Temperature-sensitive components can be held at a constant temperature. Circuits operating under laboratory conditions can be used without re-design to meet military temperature specifications. Reliability can be increased because the number of components needed is cut down appreciably when the operating temperature range is reduced.

Recent developments at the Army's Diamond Ordnance Fuze Laboratories in Washington, D.C., have made the thermoelectric device ready for use in missile and space electronics. By printed circuit technology, the device is built cheaply, reliably and with highly predictable characteristics. By ingenious jigging, it can be made in production by untrained help.

Significantly, it can be powered by an ordinary dry cell because the necessary cascaded circuitry is printed.

DOFL physicist Irving Sochard worked out the module concept and hardware under the general direction of physicist Harold Gibson.



BASE PLATE slides down corner jig rails into precise position for soldering 36 semiconductors to printed circuits on bottom of aluminum box.

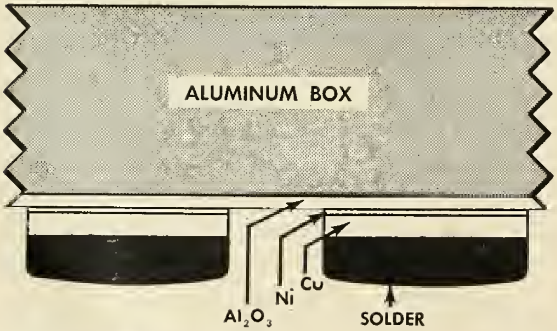
• **A forgotten theory** — Back in 1821, just a year after Hans Christian Oersted discovered that an electric current flowing through a wire can move an adjacent magnetic needle, Thomas Johann Seebeck made a discovery: a magnetic needle is also deflected if part of a circuit made up of two different conductors is heated. He erroneously concluded that magnetism—not current—could come from a temperature difference. This was a blunder that scientists are still bemoaning. It discouraged an early start on the thermoelectric devices.

A flurry of thermoelectric activity was seen in 1834 when French watchmaker Jean Charles Peltier noted thermal effect associated with a curre passing through a circuit of dissimil. conductors. Several years later a Ru sian demonstrated to the St. Petersbu Academy how he could use the "Pelti effect" to freeze a drop of water. Eve this demonstration led to no applicatio until the present century and the adve of the semiconductor.

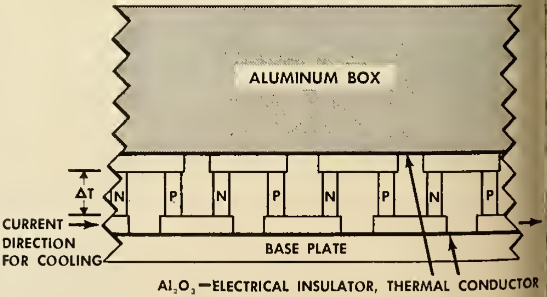
• **Active cooling**—The Army phy icists made two important contrib tions. First, they were able to cascad 18 pairs of semiconductors in serie thus the module's voltage is built up t practical values of 1 and 2 volt amenable to single electrochemical ce operation. Next, they were able to mak modules of solid circuitry do th thermoelectric job.

Currently, the module is 1 cubi inch. This volume can satisfy mos electronics needs.

Larger and smaller packages can b made. Still, there are practical limits particularly for electronics uses. Fo instance, in the near future it is doubt ful that anybody will have enoug electronics to fill a module anywher near a cubic foot. On the other hand there is a lower limit, possibly aroun 1/8-cu.-in. Here, the large radiatin surface of the insulation would override the effects of cooling and heating



CROSS-SECTION OF box and printed circuit. An anodized layer of aluminum oxide about 1 mil thick is first deposited, followed by about 0.1 mil of electroless nickel and 2 mils of copper. A Kodak photo-etching technique then brings out circuit pattern in the copper. The final step is the solder dip.


ALUMINUM BOX
ΔT
N
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P
CURRENT DIRECTION FOR COOLING
BASE PLATE
Al_2O_3—ELECTRICAL INSULATOR, THERMAL CONDUCTOR

CROSS-SECTION OF thermoelectric module, showing semiconductor circuit. The temperature difference exists between the aluminum box and the base plate, which are joined by N and P semiconductors. Note that these are electrically in series, but thermally in parallel. Current module volume is 1 cubic inch.

Design Charts

UPPER: *Current required for various oads.*

MIDDLE: *Power required for zero load.*

LOWER: *Current required for zero load ept at constant temperature.*

Thermoelectric devices are designed o control the temperature of microcircuitry in solid-state electronics. The cooling and heating is done actively. A passive system would call for fins or or running a stud to a container or adiator.

• **A misconception**—If there is a problem of simply reducing an item's emperature to ambient, a thermoelectric device is not recommended. A good heat conductor is better than a pump. Only if it is necessary to get below ambient is the Peltier effect useful.

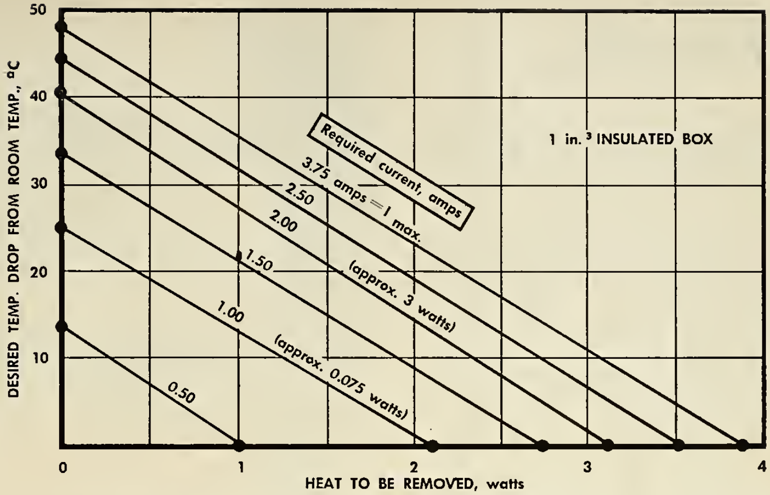
The exception is, of course, when precise temperature control of a small egion is needed while the ambient aries. An intriguing instance involves he crystal oscillator when used for me control. Usual practice is to put he crystal in an oven, which is high bove ambient temperature in order to eep the temperature constant. Drawbacks include a need for uninterrupted ower for the oven so that the crystal oes not cool, and a shortened crystal fe because of its elevated temperature peration.

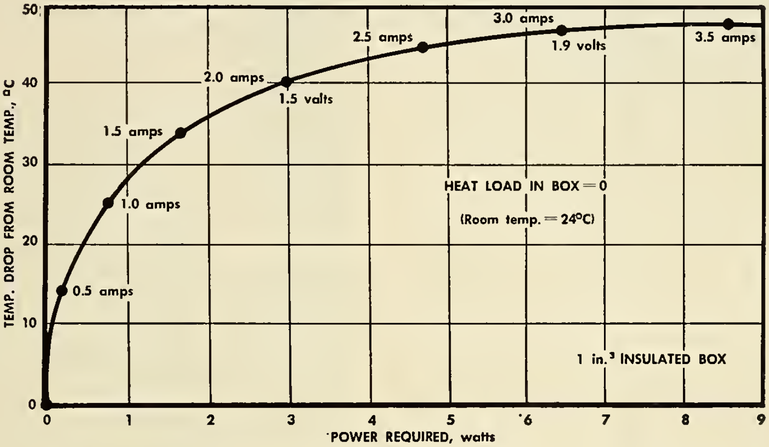
A thermoelectric module could be evised to keep the crystal at a temperature that would be appropriately set t a constant approximately equal to he average ambient. A sensor would monitor the module's temperature, and eat or cold would be added as a function of current flow and direction. ower failure would be only a minor sturbance.

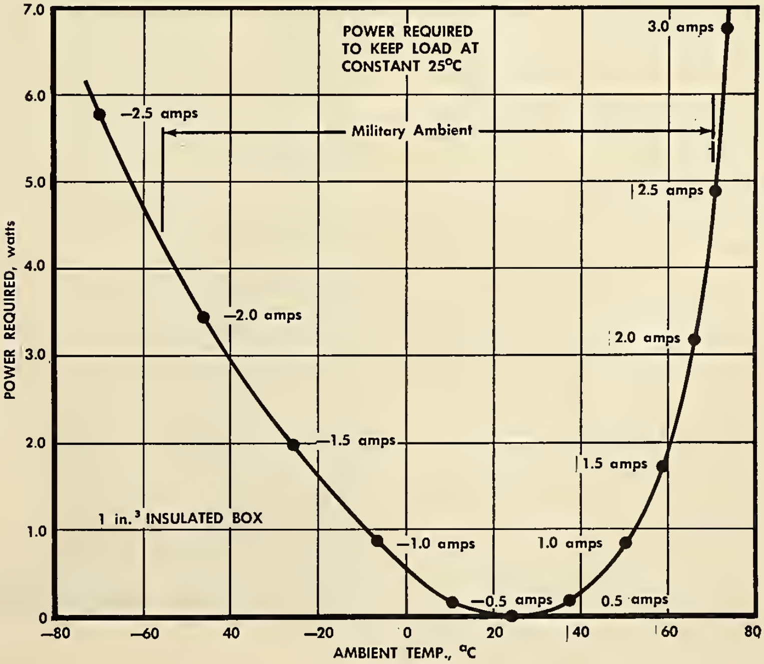
A common error is to attempt to se the Peltier effect to cool a heat enerator—for instance, a power transistor. Analogously, if an enclosure is eated by a blast furnace, a fan will o a much better cooling job than an r-conditioner.

Several hundred companies are orking on thermoelectric theory, including research on practical devices nd material. Prominent among these e CBS Laboratories, General Electric, eneral Instrument, National Carbon, CA, Texas Instruments, Westinghouse nd Whirlpool.

So far there have been no general pplications of the modules. Yet the esign charts are ready, predictability of rformance is very high, and there rtainly is a need. Sochard observes at "It's up to applications groups to ake the next move." ⌘







Army Takes Wraps Off Its EETF Work

FORT HUACHUCA, ARIZ.—The Army Signal Corps' EEIF (Electro-magnetic Environmental Test Facility) program now under way here may cost nearly $90 million before it runs its five-year course.

The present phase of the program, instigated to solve the difficult problems of radio interference within a field army command, is directed by Pan American World Airways under an $18.8-million, two-year contract. Major subcontractor is Bell Aerosystems Co.

At present, the Army says, the contract is "right on schedule," in terms of both time and money.

Contract award was made last March and work to establish the facility was started almost immediately. The initial project (phase I) is to study spurious radio emissions by duplicating a typical electromagnetic environment associated with a tactical unit of company size within a battle group, a battle group within a division and a division within a corps. Later, a corps within an Army will be studied in a 3-year phase II study.

A review of the program to date was included during a large-scale, three-day conference to acquaint the press and high ranking officials of the military with latest Army electronic equipment developments and techniques at this installation.

Twenty contractors who are working with the Army at the Electronic Proving Group in testing major prototype systems participated in the broad indoctrination.

This is the first time the gates of Fort Huachuca have been opened to newsmen for such a demonstration. The Signal Corps had much to show and say.

• **Need for EETF shown**—It has been estimated that today's field army will average 75,000 electromagnetic radiators in a 100-mile square area, said Lt. Col. Redheffer, deputy director of the EETF program. And he said the situation will worsen. Increasing power levels and greater improvements in radio receiver sensitivities can only magnify the existing interference which degrades and even interrupts communications.

The task of EETF is multiple: 1) to reveal existing incompatibilities with operational communications equipment; 2) to recommend corrective modifications; 3) to obtain data that will provide a firm basis for the design of new equipment; 4) to test new frequency assignment plans; and 5) to test new equipment and systems.

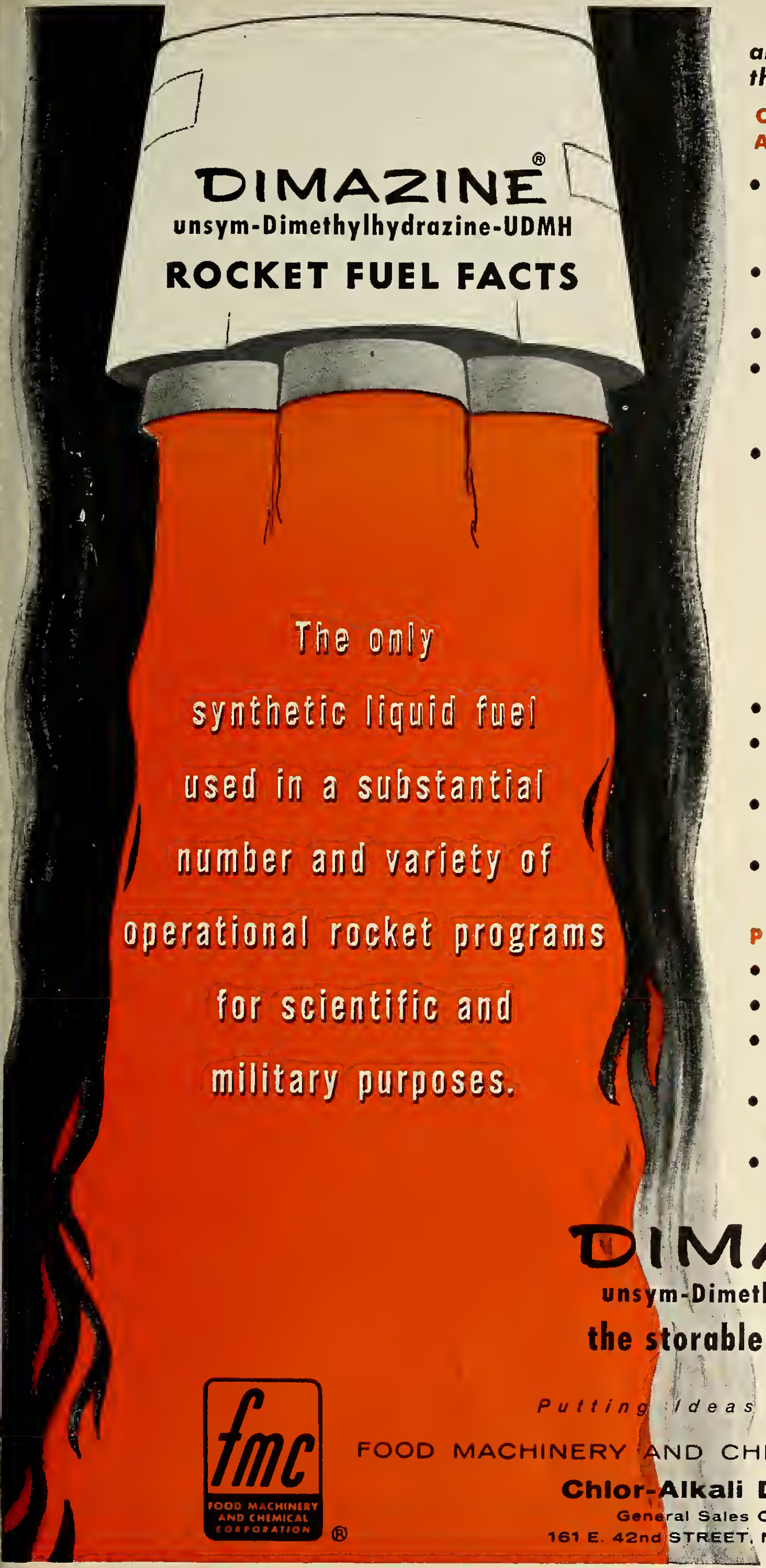
In short, the Army wants to know the degree, sources, and solution to the interference problem. It also feels that with its approach, realism is assured by including all the normal sources of unintentional radiation (vehicles, generators, etc.).

To implement its investigation Pan Am will use the Army's new IBM-709 complex at the Post's research center for analysis of test data. Mathemati models will be developed which w include propagational phenomena a equipment characteristics.

Also, standard electronic field va are being modified to simulate fi radiators. Other EETF instrumentati will permit interference detection a provide for collection of data needed develop or validate the mathemati model.

The whole program has been co dinated with the Department of D fense and Federal Communicatio

AIR-TRANSPORTABLE TROPOSCATTER. Communications systems such as th being tested at Electronics Proving Ground, can be put into operation in 7 minut



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Pilâtre de Rozier and Marquis d'Arlandes (November 21, 1783), using a Montgolfier balloon, were the first to leave the earth to test man's physiologic reactions. This experiment was the forerunner of intensive Space Medicine studies of today.

SPACE MEDICINE

There is a relatively narrow zone above the surface of the earth in which man's physiologic mechanism can function. Hence the unrelenting search by Lockheed scientists into many aspects of Space Medicine.

Engineers already have equipped man with the vehicle for space travel. Medical researchers now are investigating many factors incident to the maintenance of space life—to make possible man's flight into the depths of space. Placing man in a wholly new environment requires knowledge far beyond our current grasp of human biology. Here are some of the problems under investigation: The determination of man's reactions; the necessity of operating in a completely closed system compatible with man's physiological requirements (oxygen and carbon dioxide content, food, barometric pressure, humidity and temperature control); explosive decompression; psycho-physiological difficulties of spatial disorientation as a result of weightlessness; toxicology of metabolites and propellants; effects of cosmic, solar and nuclear ionizing radiation and protective shielding and treatment; effects on man's circulatory system from accelerative and decelerative G forces; the establishment of a thermoneutral range for man to exist through preflight, flight and reentry; regeneration of water and food.

Exploration into unknown areas such as Space Medicine, provides endless stimulation to imaginative scientists and creative engineers. Research at Lockheed's Missiles and Space Division covers the entire spectrum—from pure basic research to development work, in support of current projects. Space Medicine is but one phase of Lockheed's complete systems capability in missiles and satellites. To maintain this position of leadership calls for an extensive research and development program—ranging from electrical propulsion research to advanced computer research, design and development. Typical current projects are: Man in space; oceanography; fuel cells; space station; space navigation; solid state electronics.

Engineers and Scientists: If you are experienced in work related to any of the above areas, you are invited to write: Research and Development Staff, Dept. J-29, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed / **MISSILES AND SPACE DIVISION**

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LING VIBRATION EQUIPMENT HELPS KEARFOTT INERTIAL GUIDANCE SYSTEMS MEET THE TEST

Anything that goes into a missile has to ride out the ultimate in vibration tests. To make sure its products meet that test, the Kearfott Division of General Precision, Inc. chose Ling Vibration equipment for its own testing facility. A leader in the development and manufacture of inertial guidance systems, Kearfott supplies systems and components of various types for many major military projects—including Bomarc B, Subroc, Talos and Atlas. The Kearfott installation, one of the most modern on the eastern seaboard, was designed and engineered by Ling in cooperation with Kearfott. The system includes a 5,000 force pound shaker, power supply control console and all associated electronics for complete sine-random-complex wave testing. For information on Ling Vibration Equipment to help you to greater product reliability, write Dept. MR-7 at our Anaheim address.

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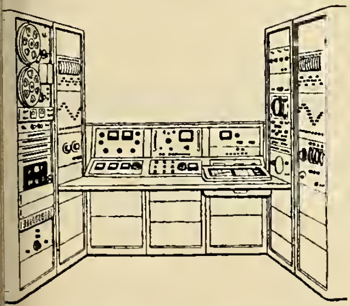
LING ELECTRONICS

The Kearfott installation shown at the left is a standard Ling engineered system. In this case, the test lab was designed so the system operator can visually monitor not only the controls but the power supply, the shaker and the specimen during the test.

While seated at the master control console, the operator is provided with centralized readout, and all essential controls are within easy reach of his fingertips. The program can be pre-set to the desired test schedule, tape programmed or selectively switched.

Since Ling system components are rack-mounted modules, the user enjoys the advantages of a system which is customized to his specifications at the most economical cost. The user is provided with a compact vibration control center which has the flexibility to expand with future needs.



Such sound and practical engineerng is common to all Ling systems—nd it contributes to convenience, ase of maintenance, and installation nd operation economies.

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Commission and with cognizant state and local government agencies. Results are being made available to the other services on a continuing basis. (For additional details on the EETF program, see M/R, Feb. 15, 1960, p. 16.)

• **New equipment highlights**—Among the vast array of new equipment shown, in dynamic or static display, were a sizeable number having missile application.

Militarized mobile computers which have been developed and will be tested at the Proving Ground will greatly aid the local field commanders.

Known as the FIELDATA family, the Army's militarized mobile computers will include a small computer for the lower echelons and the BASICPAC for more complex applications. Largest member of the family is the MOBIDIC (Mobile Digital Computer), a general-purpose, completely transistorized computer mounted in one or more 30-foot vans.

It is planned to use this system at the army level and possibly at the corps level. A prototype of the MOBIDIC is now undergoing tests at Fort Monmouth and another is scheduled for use by the Seventh Army in Europe.

Such systems will be invaluable for fire control direction for standard artillery and for unguided missiles (*Little John, Honest John*).

For communications, a whole host of versatile systems has been developed. Two mobile tropospheric scatter communication facilities were revealed—one by Collins Radio and one by Westinghouse—which permit direct multichannel transmission over distances up to 150 miles.

Geographical barriers offer no problem. M/R also learned from some of the military operators of the Collins system that from initial set-up to establishment of communications requires less than 7 minutes.

Finally, for smaller tactical radio systems, the very broadband "Log-Periodic" antenna will be used with a Quick-Erectable mast to replace combersome and heavy equipment previously used. The new antenna requires no replacement or relocation of dipoles to change frequencies; the new mast can be raised by two men (instead of the usual four) in about 1½ minutes.

Other systems offering significant advancements include:

–The PFNS (Position Fixing Navigational System) under development by Bendix-Pacific Div. The system employs four radio transmitting stations which radiate an electronic grid pattern covering the area of field army responsibility. A PFNS receiver anywhere in this grid pattern provides an operator with numerical and pictorial display of present position and past track-made-good. Service is around the clock and is accurate to better than 100 meters, according to Bendix.

–North American's Autonetics Div. displayed its "ABLE-Precise Differential Reference," an extremely accurate gyrocompass for determining True North within 30 secs. of arc. Operating time required is about 15 minutes. Simple to operate, the system permits readout through a standard transit or theodolite. Either could then be rotated through an angle to align rocket launchers, radars, or other angle-calibrated equipment.

–A pulsed-light theodolite (PLT) developed by Motorola Corp. is a recording wind-speed and direction system. Used to measure turbulence in the regions below 3000 feet which are so important for firing unguided missiles and drones, the system is automatic. Every 15 seconds a light pulse is emitted to a meteorological balloon. Reflections are recorded to measure range, azimuth angle, and elevation angle. This data is fed into a computer for conversion into wind components and eventual printout.

–First look at its new air-to-ground photo transmission system for tactical aerial reconnaissance also was permitted by the Army Signal Corp. The system will be used in high-performance drones (*SD-4* and *SD-5*, now under development) at from 1000 to 55,000 feet altitude. Initially, it requires two minutes to complete cycle from observavation, photograph, and transmission to photo processing and readout on the ground.

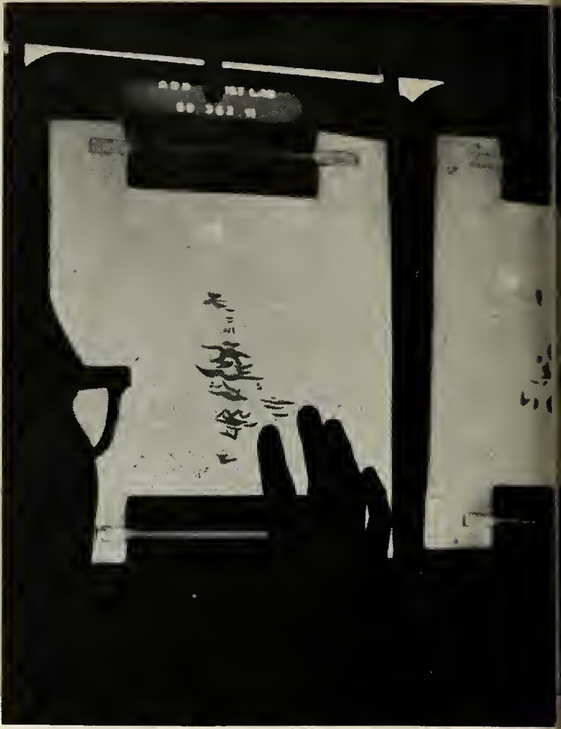
Transmission time is 8 seconds per frame. The 130-lb. aerial subsystem differs from the CBS Laboratories developed Photoscan system demonstrated earlier this year (See M/R, Feb. 15, 1960, p. 18) primarily with its optical scanner.

Resolution in the new system is from 20 to 40 lines per millimeter. Camera used is the new KA-70, 70mm high-speed, high-resolution aerial system. No other details were available on this still highly classified system.

• **Dollars delay production**—Funds have obviously been made available for expanded research and development by the Army. One point to consider, however, when reviewing all these and other advanced systems being tested here at the Proving Grounds is that most of them will not be seen as standard issue for from 2-3 years.

Why? The same old problem the Army has been plagued with following every great war—production money. Today's cold war so far has been too "cool" to provide the impetus needed to get these much needed electronic weapons in the hands of our field soldiers.

FLAWS ARE DESIGNED into the castings by the tiny silver discs which the engineer is here arranging on the pattern board.


CASTING RADIOGRAPHS reveal a given degree of shrinkage More than seven different types of defects will be X-rayed

advanced materials

'Perfect' Defective Castings Formed

by John F. Judge

A SERIES OF defective steel castings will be poured by the American Brake Shoe Co. under a Navy contract.

The problem is that each casting must contain only one defect, and this flaw must be perfect.

The purpose of the contract is to provide the Navy with accurate reference radiographs to be included in a manual covering acceptance standards for air and missileframe castings.

The rigid radiographic standards that have guided both consumer and foundryman for years are available only for sections thicker than 0.75 in. With the recent development of improved casting techniques, light steel sections have been made stronger and more reliable, with coincident increases in missile and aircraft applications.

American Brake Shoe's Research Center will produce defective castings with wall thicknesses ranging from 0.13 to 0.75 in. Each casting will be an 8 in. by 6 in. rectangle.

Alloy compositions will include 4130, 4140, 4330 or 4340, 347, 410 or 430, and 17-4PH. The specific flaws involved are inclusions, cold shuts, shrinkage, cracks, gas holes, hot tears and misruns.

Each radiograph must clearly identify the defect's shape and size. In most cases, radiographs will be made to display the flaw in several degrees of progressively increasing severity.

• **Casting variables**—Plates will be cast with and without taper to produce varying degrees of soundness. Risers will be varied in size and sometimes completely eliminated.

Chills will be used in certain instances and in other cases, an assortment of localized appendages will be attached to produce hot spots which will, in turn, generate changing conditions of internal shrinkage. Mold and metal temperatures will also be varied.

It is anticipated that as many as 240 castings will have to be made in order to achieve the required number of standards. Since the final size of the standard is small, it may be possible in some cases to get more than a single usable X-ray from a plate.

The specifications for the casting procedure were drawn up by the Naval Ordnance Laboratory, White Oak, Silver Spring, Md. These had to parallel the processes used in the production of operational castings.

Heats of steel will be melted in a basic lined induction furnace. FeMn and FeSi will be added following meltdown, and the heats killed with CaMnSi added at tap. The metal will be poured at 2900°-3150°F into ceramic molds.

Ceramic molds will be used to minimize surface defects which might be deterimental in the shooting of good radiographs.

When published, the manual will provide industry when its first standard reference for checking the quality of light steel castings. It will also act as a point of departure in the effort to improve their fabrication.

The Challenge in ASW Engineering . . .

Submarine Has Big Edge over Defense

Most urgent problem is detection of quiet, deep-running subs and development of stand-off weapons for arming surface ships

by Vice Adm. Harry Sanders USN (Ret.)*

THE GREATEST IMPROVEMENT in the submarine during World War II was the invention of the snorkel.

It largely nullified the capabilities of ASW aircraft because it permitted the submarine to cruise submerged at speeds of nearly 18 knots and also to charge its storage batteries while submerged. Aircraft radar of that time could not pick up the relatively small snorkel valve. The snorkel, because it went far to make the submersible into a true submarine, was the forerunner of the nuclear-powered submarine.

Nuclear power in itself has revolutionized naval warfare. No longer can a large modern submarine fleet be defeated by a war of attrition. There are several reasons for this.

First, because radar waves do not penetrate water, deep-running submarines cannot be detected by aircraft radar. Nevertheless, the art of sonobuoys is progressing rapidly and promises to significantly increase airborne detection capabilities.

Second, because the range of shipboard sonar detection devices is short, the chance of a surface ship getting close enough to a submarine to detect it is slight.

Third, nuclear submarines can make more speed submerged than on the surface. This submerged speed can exceed the speed of surface ships.

Lastly, nuclear submarines can remain submerged for months and can cruise in waters where no other vessel can go. The USS Sea Wolf completed a cruise during which it remained submerged for 60 days. Submarines have cruised under the polar ice, across the North Pole to Europe. The USS Triton made a cruise around the world under water in 84 days.

On top of the revolutionary advance of nuclear propulsion is the ability of the modern submarine to fire long-range missiles fitted with atomic warheads.

Another factor that will greatly increase the capabilities of the submarine is deep submergence. When the third dimension of depth is greatly increased, the tactical problem is correspondingly made more difficult. Antisubmarine weapons must be designed that will travel faster and further under water and have enhanced guidance and target seeking capabilities.

- **Surface ships vulnerable**—Modern submarines have torpedoes that are faster and cover greater distances than those of World War II. At some time in the near future, submarines will have long-range missiles such as *SUBROC*, which can be fired submerged and which go through the air for miles.

Today, surface ships do not have stand-off weapons that can compete with these submarine weapons of the future, although *ASROC*, the new antisubmarine rocket, and DASH, the drone helicopter installed in destroyers, are steps in the attainment of this objective. Until there can be developed for surface ships a long-range detection and fire-control system together with a long-range stand-off weapon, the craft will be at an increasing disadvantage against submarines.

Second in Series

This is the second in a special series of articles intended to acquaint readers with the nature of the submarine threat, the ASW engineering problems involved, and the means or lack of means for solving them. Written by authorities in the ASW field, future articles will deal with environmental factors, sonar, hydrodynamics, oceanography and ASW weapon systems.

The excellent work of Task Force ALFA in the Atlantic has demonstrated that no single vehicle and no single weapon can find and kill submarines. A team effort by a task force composed of aircraft carriers, destroyers, carrier aircraft—both fixed wing and helicopters—and hunter-killer submarines is necessary to detect and destroy modern submarines.

Much work is being done to improve the equipment that this team must have. Better communications between aircraft, surface ships, and submerged submarines are necessary. Better airborne detection devices are required and these are under development. Also needed are improved antisubmarine weapons for surface ships, submarines and aircraft. Progress has been made in sonar equipment for surface ships.

The protection of Naval task forces is a problem that is well in hand; the development of advanced sonar for surface ships, sonobuoys for aircraft, and new types of weapons should be able to meet the requirements of this type of local defense.

The protection of merchant convoys is a far more difficult problem because of the large number of ASW aircraft and surface escorts required to protect the large volume of shipping—if, as in the past, local escort is to be provided.

Great interest is shown in the development of hydrofoil boats. The U.S. Navy has let a contract to Boeing Aircraft for a PCH, a hydrofoil boat of 110 tons displacement. Hydrofoil boats were constructed by the Germans during World War II. They built boats as large as 80 tons which made 45 knots. These boats were used as transports in the Mediterranean.

The Russians have one or more such craft operating on their rivers. These craft have the advantage of being smaller, very fast, and much cheaper than the large ASW ships. There are, however, difficult problems to be overcome. Before hydrofoils can be operated in heavy seas, their operating gear and the supporting structure

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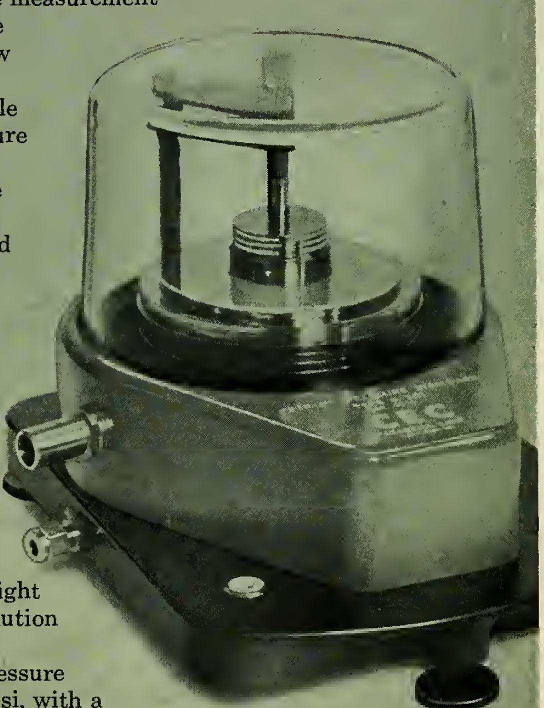
* *Admiral Sanders is Corporate Director, ASW Engineering, Chance Vought Aircraft, Inc., and a member of* MISSILES AND ROCKETS *Magazine's Editorial Advisory Board. Part I of this two-part series, a brief history of the development of submarines and ASW warfare, appeared in last week's M/R.*



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must be rigorously designed to resi the severe stresses.

• **Basic research needed**—Th scientific problems associated with th development of antisubmarine warfa are perhaps the most difficult in th whole area of defense. Electromagnet microwaves will not travel under wate therefore, radar cannot help us to fin submarines in the vast volume of th world's oceans, the area of which cove 71% of the surface of the world.

Sound, on which we depend s much to detect submarines, trave through the water in strange and sometimes unpredictable ways; it is reflecte and refracted by the boundaries c layers of water of different temperature, salinity, and specific gravity. Thu sonar equipment mounted in the hull of surface ships has difficulty in penetrating the thermocline—the boundar between the surface layer of war water and the colder water beneat This thermocline varies from 150 t 400 feet below the surface, so that submarines can hide below it. There ar also problems of cavitation whic cause rapidly moving underwate vehicles to generate so much self-nois that it is difficult to devise sonar equipment to listen through the noise.

To make matters harder, we ar dealing with an environment abou which we know very little. As someone recently put it, we know mor about the back side of the moon tha we do about the bottom of the ocean We certainly know far more abou outer space than we do about our ow inner space, the ocean.

Congress, the Navy and the scientific community are all aware of ou lack of knowledge of the ocean environment and recent appropriation have given the science of oceanograph a push forward. But it will be man years before we accumulate the information we need.

• **Future of ASW**—The most urgent problem is the detection of quiet deep-running submarines. Certainl there will be impressive development in underwater acoustics. Very probably there will be progress in device employing electromagnetic wave phenomena, and infrared.

Advanced types of sonobuoy which will provide early detection an tracking of submarines are probable New types of sonar devices installe on the ocean floor will be develope and they promise to be effective.

ASW weapons, particularly missile launched from surface vessels, submarines and aircraft will be greatly improved in range and accuracy. Jet o hydroduct-propelled underwater missiles of high speed will be developed.

Communications between submarines in the depths of the ocean an aircraft will be improved; and, unmanned underwater vehicles, nuclear-propelled and controlled electronically or programed in advance are a possibility for searching and patrol.

Developments such as these, together with the continued improvement of what we have, can reduce the present formidable advantages of the nuclear-powered, ballistic-missile-firing submarine.

(Part 2 of a 2-part series. Part 1 appeared Oct. 24)

First U.S. Measurement Institute Set up in D.C.

An Institute of Measurement Science—the first in this country—will be established at George Washington University in Washington, D.C.

Dr. Martin Mason, dean of the G. W. School of Engineering, said that the Institute will be a major factor in helping the U.S. overcome Soviet superiority in the science of measurement which has contributed greatly to Russia's missile and space achievements.

In comparing U.S. and Russian accomplishments in this field (metrology) the Bureau of Standards pointed out that in 1956 the Soviets claimed they could make calibrations of temperature measuring devices up to 000°C; their five-year plan called for extending this competence to 12,000° by 1960. By contrast, in 1956 the U.S. Bureau of Standards had reasonably satisfactory means for providing temperature calibrations of up to only 800°.

Today, NBS calibrations can be made only up to 4200°C—or about one-third of Soviet capabilities.

Electronics and space industries, which feel the "measurement pinch" most acutely, have offered equipment, money and their own employes for students in support of an academic center for metrology.

Dr. A. G. McNish, chief of the NBS Metrology Division, said that there has been nothing like the proposed center before in the field of scientific measurement. "The very security of our nation and the future vigor of science, industry and commerce in America all depend on it."

First classes at the Institute will start next February as part of G. W.'s regular curriculum.

Founding of the Measurement Institute resulted from informal discussions among members of industry, the Bureau of Standards, and George Washington University, according to Dean Mason. He said that The Martin Co. provided an initial fund of $10,000 which made the center possible.

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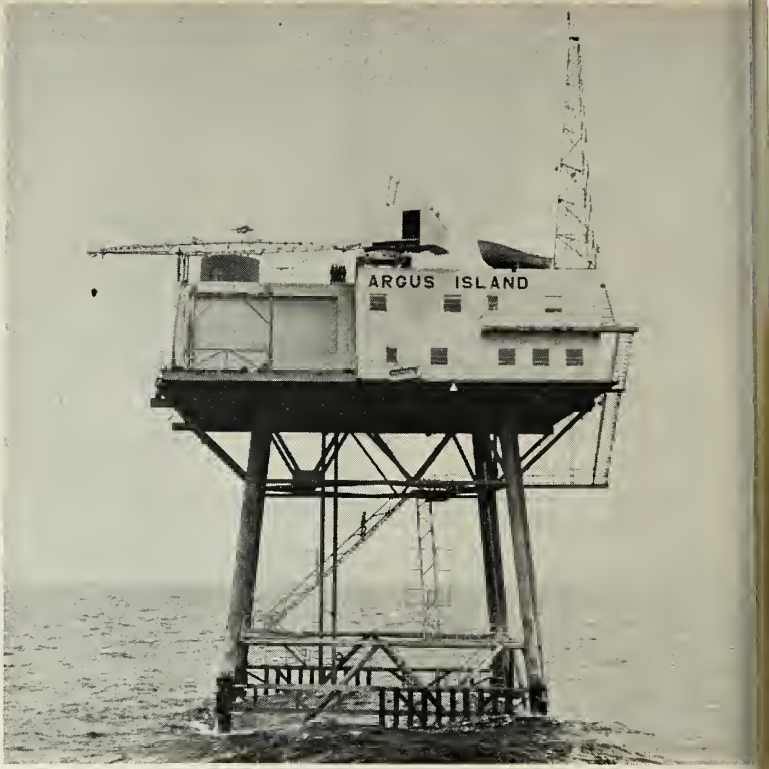
'Argus Island' Soon to be In Operation



The Navy's "Argus Island" experimental test facility off the coast of Bermuda soon will be in full operation. For the first time it will be possible to make continuous oceanographic measurements which are completely free from coastal effects.

A complete research complex has been installed on the "Texas Tower" type artificial island to study physical and acoustical measurements of the ocean.

Secondary duties for the future will be the testing of underwater detection equipment for the Navy and for marine biology experiments.

The $1.25-million island is secured by four huge columns that spread outward slightly from the tower and extend 260 feet to the ocean floor. The columns are implanted in Plantagenet Bank, 30 miles off the southwest coast of Bermuda. (Because of its nearness to Argus Bank—meaning "watchful guardian"—it was tagged with the somewhat simpler and more appropriate title.)

The main platform rises some 67 feet above mean water level. The two-level deckhouse is 85 x 85 x 24 ft. high. The upper deck carries a 15-ton crane and has space for helicopter landings.

The research program will be carried out by Columbia University's Hudson Laboratories for the Office of Naval Research. Technical personnel for operation and maintenance will be fu nished under subcontract by Land-Ai Inc., of Chicago.

British oceanographic scientists hav expressed interest in the project an probably will send research groups t the Island in the near future. Othe European scientists have been invite to make use of this particularly valuable facility for studies of their own.

mergers and expansions

LEACH CORP. has bought a two-story, 48,000-sq.-ft. building from the U.S. Relay Co., now liquidated.

BARRY CONTROLS INC. of Watertown, Mass., and The Wright Line of Worcester, Mass., have merged and will be known as Barry Wright Corp. Stock will be exchanged at the rate of one share of Barry Wright stock for each share of either Barry or Wright stock held.

AVCO CORP.'s Research and Advanced Development Division in Wilmington, Mass., has formed a new Industrial Products Subdivision. The subdivision will market products primarily in the areas of high-temperature technology and environmental simulation. Robert A. Hawkins has been appointed Director of Products in addition to his post as Manager of the Quality and Reliability Department.

OLAER PRODUCTS, INC., established earlier this year, has opened a Fluid Power Service Center in Westbury, N.Y.

A. O. SMITH CORP. will build a $2-million advanced research center at Middleton, Wis., near Madison. Advanced research activities are scheduled to begin in the new facility by the middle of 1961.

C-E-I-R of Arlington, Va., and Engleman & Co. of Washington, D.C., have completed contract arrangements for an economic merger. The Engleman facilities in Washington will be moved to Arlington, and Capt. Christian Engleman, USN (Ret.) will join C-E-I-R as vice president. The merger is C-E-I-R's second in the past thre months. In July a merger was effecte with General Analysis Corp. of Los Angeles.

FILTRONICS CORP. has been formed in Chicago for the purpose of providing filters to designers of modern communications equipment. Evangelos Argoudelis, the firm's vice president and director of engineering, and Theodore Stamatix, project engineer, were both formerly with Motorola's applied research department.

VERTOL DIVISION of Boeing Airplane Company will build a $2-million engineering research and test facility on a 15-acre tract next to its present flight test facilities at Philadelphia.

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Bid Revised

West Coast LH$_2$ Plant Put off Year by NASA

Target date for beginning operation of NASA's big new liquid hydrogen plant on the West Coast is being postponed a year.

In an amendment to its invitation to bidders, NASA moved the operational date from June 1, 1961, to June 1, 1962. West Coast requirements in the meantime will be supplied by truck and rail transport from Air Force Plant No. 74 at West Palm Beach, Fla., operated by Air Products Inc.

Opening date for bids on the new hydrogen supply was postponed a week, from Nov. 16 to Nov. 23.

Increased requirements for liquid hydrogen on the West Coast result from the award to Rocketdyne Division, North American Aviation, of a contract to develop a 200,000-lb.-thrust liquid hydrogen-LOX engine to power the second and possibly an eventual third stage of later versions of *Saturn*. Also, Douglas Aircraft Co. is developing a smaller second stage, which later will be an upper stage.

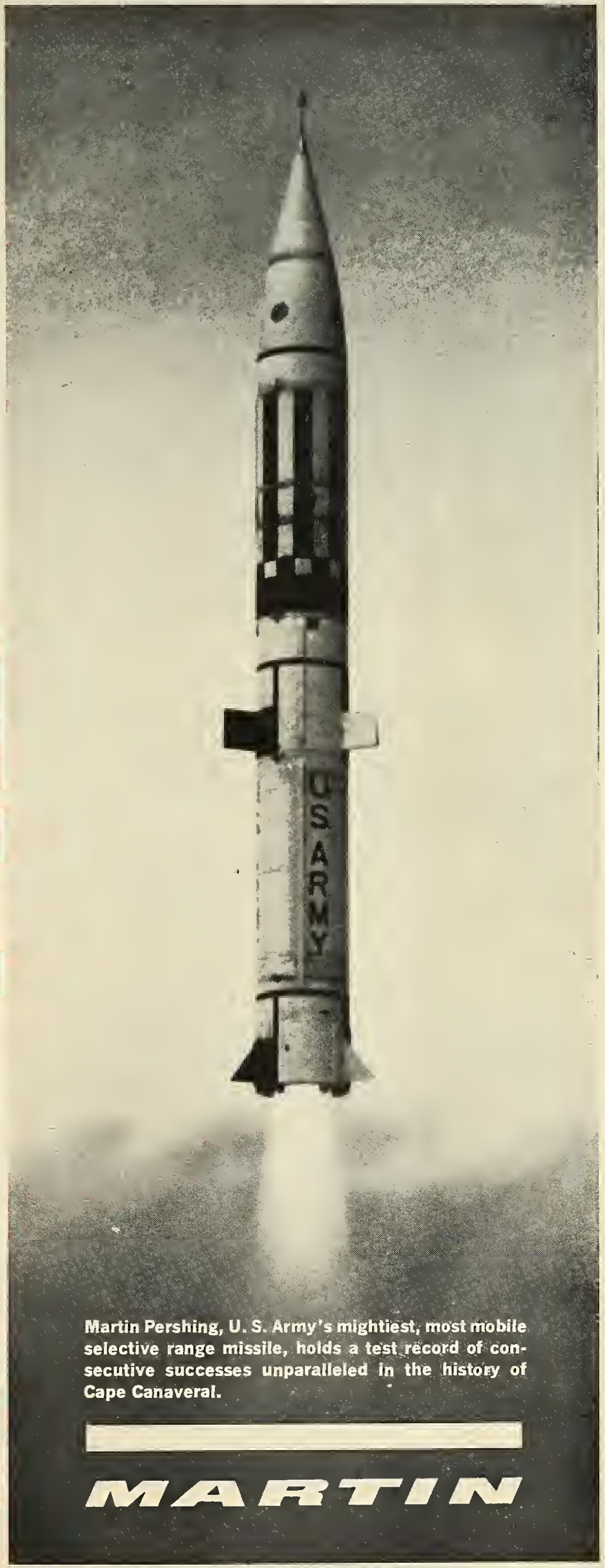
- **LOX for Centaur**—NASA's present requirements in the West—for the *Centaur* development work at Convair and for the Project *Rover* nuclear rocket work at Los Alamos—are being met by a medium-sized plant opened by the Linde Co. at Torrance, Calif., last summer.

From July 1961 until May 1962, the contractor will be required to deliver 2,976,000 lbs. of liquid to the West Coast. More than half will go to Los Angeles, with smaller amounts consigned to Sacramento, San Diego and Mercury, Nev.

The revised bid request dropped any requirement for the contractor to concern himself with supply on the East Coast. He is merely to act as a transportation service delivering liquid produced at West Palm Beach wherever NASA desires.

On completion of the West Coast plant, the contractor must supply minimums of 600,000 lbs. a month in June-August, 1962, 800,000 lbs. a month in September-December, 1962, and 1,234,000 lbs. a month and 3,700,000 lbs. a quarter during the calendar years 1963-66.

NASA requires that 1/28 of the total requirement must be delivered daily. Thus, production capacity of the new plant would have to be at least 44,000 lbs. a day, about two-thirds the total of 67,000 lbs. daily capacity of the Papa and Mama Bear installations at West Palm Beach. Linde says its Torrance capacity is 13,000 lbs. a day. ⌘



RELIABILITY

Martin Pershing, U. S. Army's mightiest, most mobile selective range missile, holds a test record of consecutive successes unparalleled in the history of Cape Canaveral.

MARTIN

Modifications Raise Polaris' Range

A-2's second-stage case will be made of Spiralloy and chances are good that the wound glass filament will be used for both stages in future models.

SUNNYVALE, CALIF.—The Navy has let contracts for production of a longer range *Polaris* fleet ballistic missile, with major revisions in the initial A-1 version.

The new model FBM, designated A-2, will have a longer first stage, a slightly shortened second stage, and improved propellants in both stages. Second-stage motor casing will be fabricated of Spiralloy. The overall effect of the changes will be to increase the 1200-nautical-mile range of the A-1 to 1500 nautical miles.

Incorporating improvements based on data gained from the *Minuteman* program, the second stage will be made by Hercules Powder Co. under a $17-million letter contract awarded by Lockheed Missiles and Space Division. LMSD received a Navy contract for $181 million to speed development of the longer range model. Aerojet-General Corp. will build the first stage for the A-2, as it has been doing on the A-1.

Polaris second-stage propellant will be almost identical to the *Minuteman* third-stage propellant, with slight modifications. The case will be of Spiralloy, a continuously wound glass filament impregnated with an epoxy resin, now used in *Minuteman*, and will be fabricated in the same manner. (See M/R, October 17, p. 36.)

Propellant will be a modified double base type, with combustion temperature over 6000°F, and an extremely high specific impulse. Mass ratio is understood to be greatly improved over the previous version; this, combined with the improved propellant and lighter case, is expected to aid performance considerably in the important second-stage phase of powered flight.

• **Labor of Hercules**—The second stage was developed at the Allegany Ballistic Laboratory, operated for the Navy by Hercules. It will be produced at Hercules' Bacchus, Utah, works, which expects to add some 500 employes.

Production of the A-2 second stage will begin within a few weeks. Contract negotiations will probably be completed by Nov. 1. Award of the contract reportedly was greatly influenced by the performance of Hercules' third-stage *Minuteman* motor.

The first stage, now being tested by Aerojet at its Sacramento Solid Rocket Plant, has a steel case, and is powered by an improved propellant. Aerojet points out that it did not have a production contract for an improvement on the second stage, but developed one for
potential use in reaching the require
1500-nautical-mile range. The Navy ha
not officially designated the Aerojet cas
as a backup for the Hercules effort, b
it is expected to do so.

Werner R. Kirchner, Senior Div
sion Manager of the *Polaris* project
Aerojet, said the award of the A-2 se
ond-stage contract to Hercules will n
cause a reduction in the work force
the company's *Polaris* program.

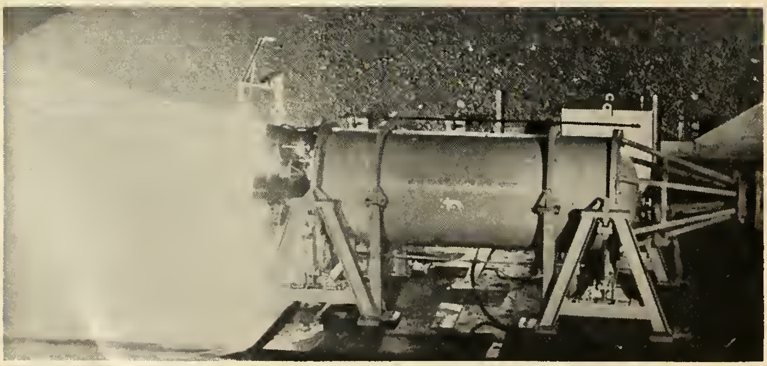
• **Setbacks for titanium**—Aerojet
known to have developed a high-pe
formance titanium case for the thir
stage *Minuteman* which eventually lo
out to the Spiralloy case. It is likely th
the firm's second-stage *Polaris* A-2 ca
is also titanium.

Titanium's defeat by Spiralloy
two such significant applications, whe
extreme performance is required of
very lightweight case, may indicate
trend that will lead to non-metall
motor cases in a great many rock
motors for future vehicles, especial
since there are no practical limits on t
size of the Spiralloy case.

There's also a definite possibili
that the cases for both stages of *Pola*
rocket motors may be fabricated of
material such as Spiralloy—if the Na
seriously pursues the goal of a 340
nautical-mile missile, as predicted
some highly placed sources. So f
however, no production contracts ha
been let on an A-3 version of t
Polaris.

• **Much is unchanged**—Overall d
sign of the A-2 FBM is essentially t
same, with the major changes appli
mostly to propulsion. Stage length
case materials and propellants ha
been modified; but guidance, thrust ve
tor control technique (jetavators), a
other subsystems are basically u
changed.

The length of the launch tube in t
FBM submarines had been greater th
required for the A-1 series of *Polar*
A margin of several feet was availa
for lengthened missiles. There are co
tradictory reports as to whether or n
the overall effect of the stage-leng



Minuteman Nozzles Pass Test

SECOND-STAGE MOTOR for Minuteman is fired in full-duration hold-down test in Aerojet-General's Solid Rocket Plant at Sacramento. Highlight was successful operation of movable nozzles.

alterations on the A-2 takes up this marginal space.

The award to LMSD of the $181 million for R&D in Fiscal 1961 brings to $608 million the funds awarded Lockheed since 1956 for research and development on the FBM program. Additionally, the Navy has awarded LMSD $490 million (as of July 1) for production of flight test vehicles and initial orders for tactical missiles and associated hardware. Another $5.5 million was received for miscellaneous support services.

Contracts during Fiscal 1961 for operational missiles and flight test vehicles to implement the long-range development program are not yet finalized, but are expected to be "substantial."

Lockheed says the program acceleration has chopped three years from the original schedule laid out for the FBM. About 80 flight tests and thousands of ground tests have been conducted during the program. ⁘

AT&T Awaits FCC Okay For Satellite Experiment

Several months' delay in the start of work on the first commercial communications satellite seems likely while the Federal Communications Commission decides whether to grant permission.

The American Telephone & Telegraph Co. applied on Oct. 21 for the right to use the frequency bands 6425-525 megacycles and 6775-6875 megacycles to make an experimental launching within a year. However, the FCC is expected to conduct a lengthy investigation before deciding on the application.

There probably will be hearings. In addition to its request for the two 00mc bands, AT&T asked the commission to set aside the remaining 300mc bandwidth of the 6425-6925 megacycle region for satellite communications.

In the first experiment, AT&T plans reversible one-way television transmission, alternatively with a series of telephone, telegraph and data transmission experiments. For later launchings, simultaneous two-way television transmissions and communications experiments are planned. The 500mc bandwidth would provide for the simultaneous experiments.

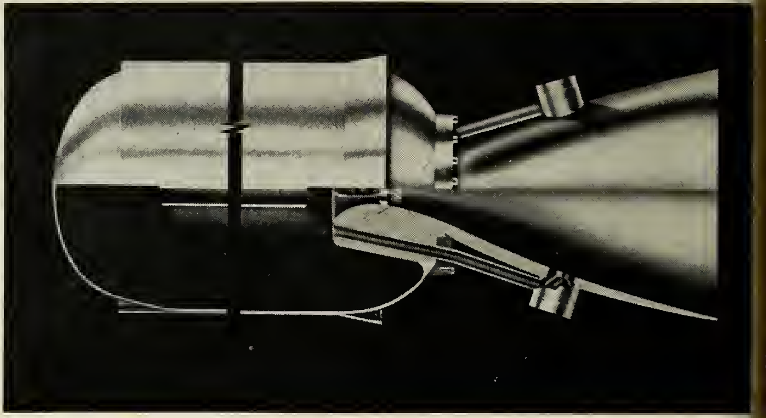
Some Washington observers thought possible that the FCC might, after investigation, grant permission for the one-year experiment without a hearing. Under such an arrangement, the commission then would hold a hearing on reserving the additional 300mc bandwidth requested for future experiments. The latter hearing might also be combined with an investigation the commission already has scheduled for next March of long-term needs for space communications.

Air Force-Martin Mace B, 1200-mile inertial guidance tactical missile, incorporates the proven basic design of Matador and Mace A—operational missiles with outstanding records of years of reliable front-line service.

MARTIN

Cluster Seen for Big Solid Booster

Aerojet may draw on AF Project 3059 experience to develop design for NASA vehicle weighing 7 million lbs.



1970 VINTAGE SOLID motor in Aerojet's forecast will have mass fraction of 97. Steering is controlled by novel gas bleed from chamber to vector nozzle exhaust.

SACRAMENTO, CALIF.—No scientific breakthroughs are required for development of solid rocket motors developing thrusts in the neighborhood of 20 million pounds, according to officials of Aerojet-General Corp.

NASA last week named Aerojet one of three companies to receive preliminary design contracts for solid boosters of up to seven million pounds gross weight, with thrusts of two to three times that weight (M/R, Oct. 24, p. 17).

Karl Klager, manager of Aerojet's Solid Propellant Development Division, says a likely approach to such a vehicle would be one with seven clustered engines, each approximately 100 feet long by 120 inches diameter.

• **Engines segmented**—In this design, Aerojet would draw heavily on experience with its huge Project 3059 solid segmented rocket now being developed under a $4 million Air Force contract.

First static test firing of this rocket is scheduled for next year.

Although no scientific breakthroughs are required, a number of advances in state of art will be designed into the seven million pound gross weight vehicle. These include:

–The use of more energetic oxidizers, fuels and binders to increase propellant performance.

–The reduction of insulation by employing propellant as an insulator.

–The design of unique steering valves to bleed gases into nozzle for steering.

–The use of advanced material such as plastic binders.

"The system is directed toward material development," according to Klager. He reports glass, for example, is considered to have great hope for the future. These developments may result in solid rocket engine with mass fraction of 97.5% compared to today's 85 and 90%.

"What we are trying to do in the next few years is demonstrate we can build really large segmented rockets," the Aerojet official states. Klager believes replacement of liquid boosters like *Saturn* by solids could be accomplished close to the present timetable set by NASA for *Saturn.*

• **Test facilities modified**—Aerojet's program on Project 3059 is expected to lead to large solid rocket well over one million pounds thrust. The company is at present modifying its horizontal solid test facilities to handle rockets this size, with 1.5-million pounds thrust as limit. Since the size can continue to be increased by the addition of segments, the future usefulness of test facilities here is limited.

"We now are getting into propellant quantities that require another site," admits Dan W. Tenebaum, Aerojet's Test Division manager.

It is quite likely Aerojet will shift to a water-based site for testing solid engines of larger size. E. R. Roberts, asst. manager of A-G's Solid Rocket Plant, says NASA's decision to study giant solid boosters with multi-million pounds thrust could substantially reduce the cost of space exploration.

"The most productive and inexpensive vehicle for space exploration is one which combines low cost, large thrust, solid fuel boosters with highly efficient liquid propellant upper stages," he says.

Kiwi A3 Checks out Fine Under a Full Power Runup

NEVADA TEST SITE—The third t
in the *Rover* program was term
"highly successful" here after the 1
minute full-power minute run of Kiv
A3, four days after the origina
scheduled date. The test, probably l
in the Kiwi-A series, was held up d
to very bad weather conditions at t
test site.

The reactor, six feet tall and abo
as broad, had an external appearan
similar to that of its predecessors, b
a re-designed fuel core. Kiwi-A-Pri
had spewed out a cloud of sparks p
sumed to be fuel elements during
full-power run.

The series consisted of three
actors, Kiwi-A, Kiwi-A-Prime, and K
wi-A3. The joint effort was under
rection of the Atomic Energy Co
mission and the National Aeronaut
and Space Administration.

The fission reactor used urani
fuel (U235) to heat high-pressure g
eous oxygen to thousands of degrees
seconds. Future tests will utilize liq
hydrogen, as will the flyable rocket.

Tests of the Kiwi-B series, expect
to begin in late 1961, will be the fi
to use the liquid hydrogen.

ordiner Outlines GE's rive into Advanced Areas

General Electric is rapidly developig ventures in five new fields of adanced technology, Ralph J. Cordiner, hairman of the Board, has disclosed.

They are: 1) power generation from uclear sources and other new sources,) jet engines for commercial aircraft nd stationary gas turbines for industry nd utilities, 3) space vehicle and reted activities, 4) specialized and allurpose computers, and 5) industrial ectronic projects directed toward utomation.

Cordiner cited a reorientation in e company from traditional apparais and consumer goods to products of ore advanced technologies. A quarter f the company's total business, or ver one billion dollars, is in the field f electronics.

Net sales for the first nine months mounted to $3 billion, down 3% from e same period last year. Earnings ere down 11%, to $169 million. Third uarter totals were: Sales down 4% to 1 billion, earnings down 20% from e same period last year to $57.5 illion. Back orders total 12% more an the same time last year.

"The total electrical industry is perating at not much more than half apacity," Cordiner said.

This reflects both expanded capailities of major producers and the enance of so many new competitors in is field. Early development costs of ew ventures, such as GE's, contribute o lower earnings.

all Building NASA's olar Watch Satellite

Ball Bros., Boulder, Colo., is buildig a solar observation satellite for unching in the first quarter of 1961.

Deputy Administrator Hugh L. Dryen of the National Aeronautics and pace Administration said recently the atellite, weighing about 350 lbs., will e launched by a *Thor-Delta* vehicle nto a nearly circular orbit with an ltitude of 300 miles.

The satellite, called Orbiting Solar bservatory (OSO), will make spectrohotometric studies of the sun's ultraiolet and X-ray radiation, in addition o some secondary experiments.

The OSO consists of two sections. he base section is of large diameter Dryden did not specify exactly) and 0 to 16 in. thick, with extended arms o form a gyroscope wheel for spin tabilization. The upper section, halfisc shaped, will carry solar cells to harge the nickel-cadmium batteries.

The spin axis of the base will be riented perpendicular to the line joinig the satellite and the sun.

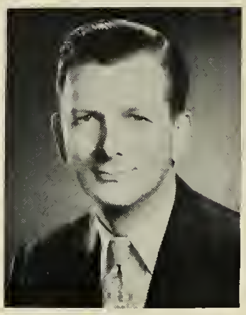
RELIABILITY

Martin-Army Missile Master electronic air defense systems were delivered ahead of schedule and under contract price. The first of these has been in operation 24 hours a day for more than two years—with virtually 100% availability.

MARTIN

names in the news

HARTMAN


COLLIER

NAWALINSKI

Dr. Lawton M. Hartman: Appointed associate director of research-operations at Philco Corp. Prior to joining the firm's Technical Systems Planning Group in 1958, he was associated with atomic energy and ICBM programs at General Electric.

Bernard J. Warren: Former general manager of Altee Corp's Applied Dynamics Division, named manager of development engineering.

John F. Hinchey: Elected director of quality control for Pacific Semiconductors, Inc. Was formerly with the Electrodata Division of the Burroughs Corp.

Leonard Sternfield and **Dr. Richard B. Dow:** Join the engineering staff of The Martin Co.'s Baltimore division. Sternfield, formerly working in flight mechanics research for NASA, is chief of the flight dynamics section. Dr. Dow, who formerly participated in scientific research for the Air Force ARDC, is principal engineer of systems criteria.

Emo D. Porro: Arnoux Corp. vice president-marketing, named vice president, Operations. He will continue marketing activities.

Raymond E. Wiech, Jr. and **Robert F. Strauss:** Elected president and vice president, respectively, of the recently founded Astrosystems, Inc. Both were formerly affiliated with Thiokol Chemical Corp.'s Reaction Motors Division.

Sheldon Newburger: Named director of Adler Electronics, Inc.'s Operations Division. Prior to joining the firm in 1958, he was chief mechanical engineer for Otis Elevator Co.'s Electronic Division.

Thomas E. Nawalinski: Former chief applications engineer, named manager of sales promotion and advertising for Non-Linear Systems, Inc. Prior to joining the firm in 1956 he headed the *Atlas* missile autopilot test equipment group for Convair-Astronautics.

Dr. Richard W. Damon: Joins Microwave Associates, Inc. as director of a research and development group on microwave solid-state control devices. Was formerly a research physicist with General Electric Co.'s Research Laboratory in Schenectady.

Arthur E. Hartung: Joins Elion Instruments, Inc. as manager, Product Engineering Dept. Was formerly manager of RCA's Special Projects Unit of the Radar Advanced Project Development Dept.

George Zissis (Ph.D) and **Gwynn Suits** (Ph.D.): Both of The University of Michigan's Willow Run Laboratories, appointed to the government's newly-formed Technical Advisory Group for Ballistic Missile Defense. Dr. Zissis is head of The Ballistic Missile Radiation Analysis Center and Dr. Suits is head of the WRL Infrared Laboratory.

Dr. Donald W. Collier: Former president of the Thomas A. Edison Research Laboratory Division of McGraw-Edison Co., joins the Borg-Warner Corp. as vice president-research.

Col. Richard K. Jacobson: Appointed director of information for the Air Research and Development Command, replacing **Col. William S. (Pug) Evans,** now assistant director of information, Office of the Secretary of the Air Force.

Daniel S. Schwartz and **Aaron Waldman:** Join Gulton Industries, Inc. as senior research physicist, Research and Development Division, and supervisor of the Instrumentation Division's Electromechanical Group, respectively. Both were formerly senior project engineers with the Kearfott Division of General Precision, Inc.

Herbert E. Weyrauch: Appointed sales manager of Electronics Control Div., Flo-Tronics, Inc. He will also assume all national marketing activities.

Robert C. Main: Joins Sperry Products Co., a division of Howe Sound Co., as manager of engineering, a newly-created position. Previous post: American Machine & Foundry, where he was responsible for the design of the *Terrier* guidance system.

contracts

NASA

Nacimco Products, Inc., San Diego, for cry genic precision measurement instrument Amount not disclosed.

$6,000,000—Chance Vought Aircraft Co Dallas, prime contractor for the *Scou* launch vehicle system.

$404,000—Lockheed Nuclear Products, Atlant for a low-power reactor to be used fc critical experiments at Plum Broo facility.

$372,716—Compudyne Corp., Hatboro, Pa., fc services and materials for an integrate automatic tunnel control system.

$225,000—Bivins and Caldwell, High Point N.C., for services and materials used fo repair and/or recalibration of instru ments.

MISCELLANEOUS

$4,400,000—Avco Corp.'s Lycoming Div., fo production of additional missile rocke chambers.

$105,200—Airite Div., of The Electrada Corp. for titanium pressure vessels to be use in missile programs.

NAVY

General Dynamics Corp.'s Convair Div., Sa Diego, for design of a real time computation system for the Pacific Missil Range. Amount not disclosed.

$181,000,000—Lockheed Missiles and Spac Div., Sunnyvale, Calif., for research an development of long-range *Polaris* missiles.

$32,500,000—General Dynamics Corp.'s Convair Div., Pomona, for production o *Terrier* and *Tartar* guidance and control groups and other components.

$26,800,000—The Johns Hopkins Universit Applied Physics Laboratory, Silver Spring Md., for continued R&D in the fleet Bumble Bee guided missile program.

$9,294,465—General Electric Co., Washington, D.C. for submarine propulsion systems.

$4,000,000—Sperry Gyroscope Co., Great Neck, N.Y., for the "key" navigational systems in five new *Polaris* missile-launching submarines.

$3,689,534—Aircraft Armaments, Inc. Cockeysville, Md., to design, develop and fabricate submarine ASW training facility, Pearl Harbor.

$1,000,000—Specialty Electronics Development Corp., Syosset, N.Y., for phosphate glass radiation dosimeters and antenna multicouplers. (Two contracts).

$110,598—The Martin Co., Baltimore, for hydrofoil craft structural study program.

$73,466—Minneapolis-Honeywell Regulator Co., Hopkins, Minn., to design and fabricate *Redeye* simulator.

$50,000—American Research and Mfg. Corp., Rockville, Md., for design of wind tunnel and hydrodynamic models.

AIR FORCE

$1,527,933—General Electric Co., Syracuse, N.Y., for services for onsite operation and maintenance of the AN/FPS-17 radar systems.

$1,527,000—General Electric Co.'s Heavy Military Electronics Dept., for operation and maintenance of radar sets overseas.

$524,000—Federal Electric Corp., Paramus Industrial Park, N.J., for non-personal services for phase-out activities from operation and maintenance of White Alice System in Alaska.

$233,000—The Martin Co., Orlando, for *GAM 83* guidance equipment for installation in F-105D aircraft.

$182,656—United Shoe Machinery Corp.'s Research Div., Advanced Development and Systems Dept., for design, development and manufacture of scoring systems for an advanced rocket-powered target.

ARMY

amilton Standard's Electronics, for the study and development of electron beam welding of electrical connections for micro-assemblies. Amount not disclosed.

,130,009—Sperry Utah Engineering Div., Sperry Rand Corp., Huntsville, Ala., for continued research and development of the *Sergeant* missile system.

,425,380—The Martin Co., Orlando, for replenishment spare parts, research and development, ground support equipment, launchers, and engineering services on the *LaCrosse* weapon system. (Six contracts).

,350,000—Aerojet-General Corp., Sacramento, for rocket motors for the *Hawk* missile system.

22,032—Douglas Aircraft Co., Inc., Santa Monica, for *Nike-Hercules* booster fin shipping kit and shipping containers.

14,000—Nassau Construction Co., Inc., Woodside, N.Y., for improved *Nike-Hercules* control systems, schedule 1, various sites in New York.

00,061—The Martin Co., Orlando, for modification of GFE vans to *LaCrosse* system and procurement of Lacrosse range safety ground stations.

87,737—Western Electric Co., Inc., N.Y. for *Nike* replenishment spare parts. (Five contracts).

50,413—Douglas Aircraft Co., Inc. Santa Monica, for *Nike* replenishment spare parts.

1,000—The Martin Co., Orlando, for *Pershing* weapons system.

expansions

AUTONETICS, INC. has estabshed a Quality, Reliability and Standrds technical division at Downey, alif. Robert E. Moore, who has been ith North American Aviation for five ears, will head the division.

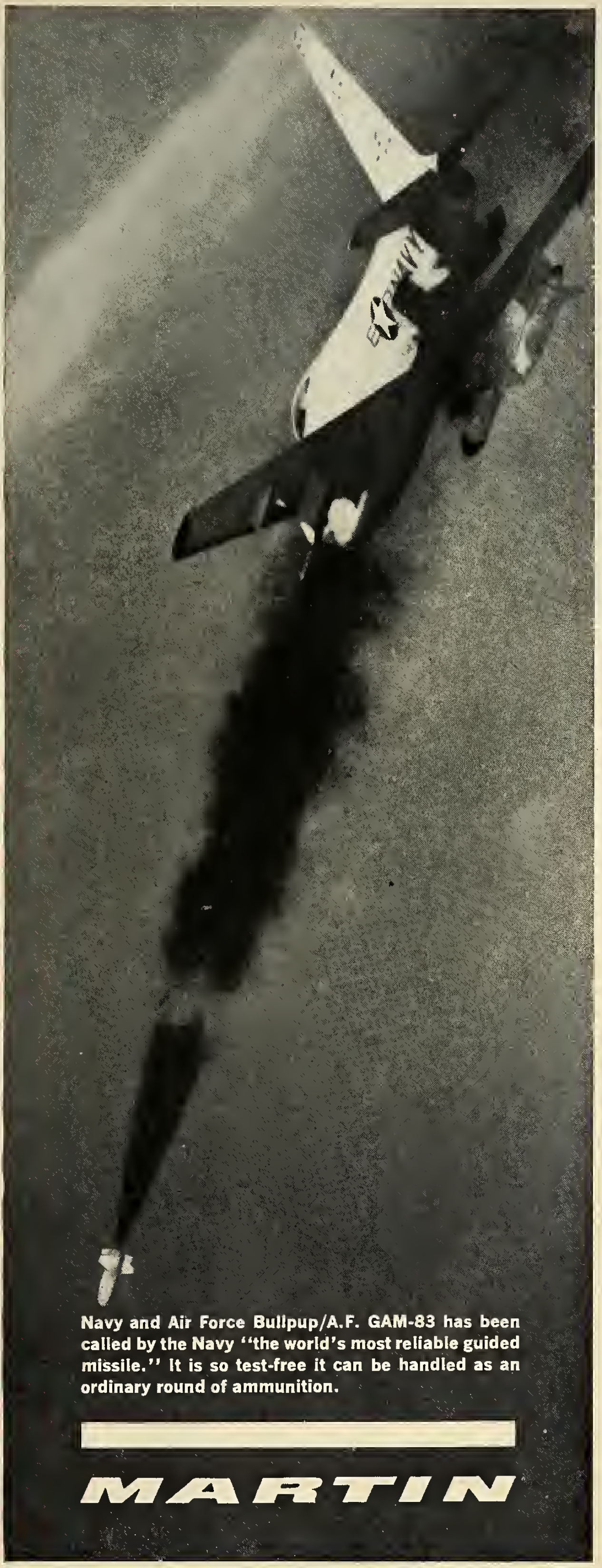
SYLVANIA ELECTRIC PRODCTS INC., subsidiary of General elephone and Electronics Corp., has roken ground on a new electron tube esearch development center at Emorium, Pa. The 6500-sq.-ft. addition the refractory metals processing plant f the Chemical and Metallurgical Diision will be completed late this year.

VANADIUM-ALLOYS STEEL CO. as organized a Cast-to-Shape Products ept. to meet the requirements of merican industry for tool and special eel castings.

MARQUARDT CORP.'s Cooper evelopment Division will move from onrovia, Calif., to Van Nuys, locaon of Marquardt's Power Systems roup. The move is expected to proide greater depth and scope to Coop's operations by access to the larger cilities.

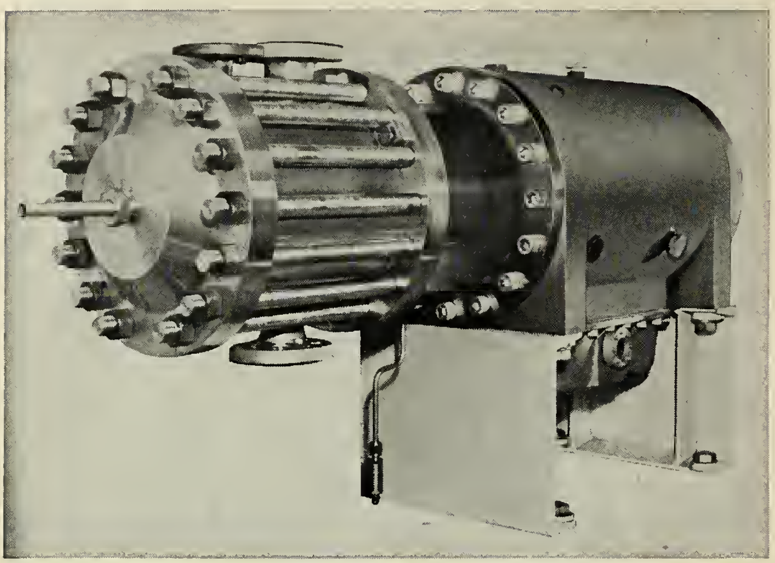
KOLLSMAN INSTRUMENT ORP. has formed a Research Division undertake basic and applied research lated to advanced tracking, computg, communications, control, instruentation and display systems. Dr. rthur S. Robinson has been appointed rector of research.

RELIABILITY



Navy and Air Force Bullpup/A.F. GAM-83 has been called by the Navy "the world's most reliable guided missile." It is so test-free it can be handled as an ordinary round of ammunition.

MARTIN



High-Pressure, High-Flow Pump

The Cosmodyne Corp. is manufacturing a high-pressure, high-flow cryogenic pump, which delivers up to 20 gpm (equivalent to 120,000 std. cu. ft./hr. of nitrogen gas) at pressures up to 15,000 psi.

The unit is a 5-cylinder, fixed displacement pump, with pistons driven by one-piece push rods in contact with a rotating, axial swash plate.

The lubricated drive end of the pump operates at ambient temperatures, thus eliminating lubricant freezing. The cryogenic section, where the pumping of the liquefied gas occurs, contains the pistons, cylinders, and valves, and operates free of any lubrication. The intermediate section provides a thermal barrier to separate the cryogenic and ambient ends of the pump together with housing seals which prevent lubricant contact with the cryogenic fluid.

Circle No. 225 on Subscriber Service Card.

Air Bleeder Valve

An air bleeder valve for hydraulic circuits has been developed by The Lenz Co. The valve is designed to be installed at the highest point in the hydraulic circuit, the point at which air accumulates.

The Lenz Bleeder Valve is of compact, functional design with only two metal parts. No packings are employed. The valves are available in range of popular sizes in cadmium plated steel, and in stainless steel on special order.

Circle No. 226 on Subscriber Service Card.

Electronic Soldering Flux

A mildly activated resin type flux called the Fusion RU series has been developed by Fusion Engineering. The flux has been tested neutral both before and after soldering making it acceptable for electrical and electronic work where non-conductive, non-corrosive flux residues are required.

A wide range of metals are easily wet by the flux. Included metals are mild steel, brass, copper, tin, lead, cadmium, and silver plate.

Circle No. 227 on Subscriber Service Card.

Full Vision Digital Clock

Pennwood Numechron Co. has developed a direct reading full vision in line digital clock.

Some of the features of this clock are: digits that can be reset individually by independent front panel reset controls, large 5/8 in. digits on the 1 hour clock and 5/16 in. digits on th 24 hour clock and calibrated rotatin visual 1 RPM seconds wheel. Cloc movement built to withstand shock o 2000 lbs./in.

Circle No. 228 on Subscriber Service Card.

Squeeze Action Valve

Airmatic Valve, Inc. has available Tube-O-Matic valve (R) in whic squeeze action automatically control the flow of air, oil, chemicals and eve grinding slurries, without the use o poppets or spools. There are no metal to-metal contacts and no metal-to rubber seals.

When the valve is open, suppl pressure through the inlet port force an elastic rubber sleeve against th tube, forcing the media to flow aroun the inlet plug and through the outle port.

To close the valve, pilot pressure i applied between the inside diameter o the tube and the outer periphery of th rubber sleeve. This collapses the sleev over the rounded ends of the inlet an outlet end plugs, sealing off the suppl pressure. The only action is the flexin of the sleeve.

Circle No. 229 on Subscriber Service Card.

Radiation Measurement

An expansion of its radiation mon toring products and services has bee announced by Allied Research Assc ciates, Inc. Plastic scintillators are no available in three types having pea emissions at 4200, 4350 angstroms Fluors of special chemical compositio or emission spectra are prepared o request.

Scintillators are now produced i many dimensions with considerable em phasis on special configurations. Cy inders can be manufactured up to 4 in. in diameter and in various lengths slabs to maximum dimensions of 3 f and in thickness ranging from ¼ i to 1 ft.

Circle No. 230 on Subscriber Service Card.

Swivel Joints Series

A series of swivel joints designe for use in servicing fluid systems available from Consolidated Contro Corp.

The joints permit turning of rigi and semi-rigid lines carrying such flui as nitrogen gas, petroleum fuels, hy draulic oils, helium gas, lithium chlo ide, and cryogenic liquids.

Low swivel torques, ranging from 16 lb.-in. for a ¼-in. swivel to 240 b.-in. for a 2-in. liquid oxygen joint, re maintained through an ambient emperature range from –420° to 275° vith adequate safeguards against momentary exposure to the heat of missile lame spill-over.

Circle No. 231 on Subscriber Service Card.

Viton Compound Developed

Haveg Industries, Inc., Taunton Division, has developed a new Viton compound based on duPont's Viton B polymer. The compound is approved under MIL Spec 25897C covering high temperature, oil and fuel resistant elastomers. Designated as Haveg Grade 16075, it was especially formulated to provide superior compression set resistance under severe operating conditions.

Circle No. 232 on Subscriber Service Card.

Parametric Amplifier

A V-8350 parametric amplifier providing a wide instantaneous bandwidth of 35 to 40 megacycles, low overall noise figure of 2.0 db. and stable gain of 20 db is available from Varian Associates.

The V-8350 uses two wideband variable reactance up-converters for simultaneous amplification and frequency conversion of a signal and its associated source of local oscillator power.

By pumping both converters from the same source of X-band power, the IF frequency stability is maintained even with variations in pump frequency or phase.

Circle No. 233 on Subscriber Service Card.

lexible Printed Circuits

Continental-Diamond Fibre Corp. has available copper-clad unsupported Teflon and single-ply glass fabric Teflon grades for flexible printed circuit applications.

CDF has designated its copper-clad unsupported Teflon grades as DI-CLAD T-1. It is available in widths up to 8 in. lengths up to 42 in., and base thicknesses 0.003 in. to 0.060 in.

Circle No. 234 on Subscriber Service Card.

RELIABILITY

The Cape Canaveral test record of Martin's Titan ICBM is, according to the Air Force, "the best success ratio to date" in USAF missile programs.

MARTIN

Propellant Briefs from Callery Chemical Company

Diborane: Fuel for Rockets, Ramjets, Turbojets—Diborane (B_2H_6) is available in development quantities on a commercial basis and will be produced in tonnage quantities as the basic building block for pentaborane at the Callery-operated, government-owned Muskogee, Oklahoma plant.

Development quantities of up to four pounds are shipped from Callery, Pa. Insulating techniques used for shipment and storage insure maximum stability.

Write for technical bulletin C-202 and handling bulletin C-201.

Triethylborane: Effective Igniter and Fuel—Triethylborane $(C_2H_5)_3B$ is a fuel for ramjets and is used as an igniter for rocket and turbojet engines.

Write for TEB technical bulletin C-310, and TEB handling bulletin C-311.

Nitronium Perchlorate: (NO_2ClO_4) a solid oxidizer, is proving useful in various rocket system applications. Not shock sensitive when pure.

Write for bulletin C-1200.

Pentaborane (B_5H_9): New Fuel for Air Force—Potential of pentaborane as a fuel is illustrated by its high heat of combustion of 29,000 Btu/lb. and its high specific impulse. T. O. Dobbins in WADC TR 59-757 reports the following shifting equilibrium impulses for pentaborane:

Oxidizer	Isp 1000/14.7 Psia.	Isp 1000/.2 Psia.
OF_2	367	466
F_2	360	460
O_2	327	421
NF_3	326	413
H_2O_2	316	399
ClO_3F	306	391
N_2O_4	306	390

Write for bulletin—Pentaborane C-3100.

For information or technical service: write Defense Products Dept., Callery Chemical Company, P.O. Box 11145, Pittsburgh 37, Pa.
TWX Evans City, Pa. 136 • Phone Evans City 3510

CALLERY
CALLERY CHEMICAL COMPANY

Benjamin S. Yaffe
Product Manager
Fuels and Propellants
Callery Chemical Company
Callery, Pennsylvania

Circle No. 10 on Subscriber Service Card.

new literature

FUSION WELDING — Sciaky Bros Inc., has published a pictorial report c their developments in highly precis fully automatic fusion welding equipment. Features include actual applications where subject equipment has bee in use for the past two years in Nort American Aviation's B-70 Program Raytheon's "Hawk" processing, as wel as others. Equipment descriptions ar also contained.

Circle No. 200 on Subscriber Service Card.

MAGNET WIRES—A 50-page catalo covering General Electric's complet line of magnet wires has just bee issued by the company's Wire an Cable Dept. One feature of WC-828 covers such types of wire (according t insulation) as Formex, Alkenex, polyurethane, cotton, nylon, Teflon, glas fiber, Dacron glass, asbestos, self-bonding, solderable, and others which ar combinations of these.

Circle No. 201 on Subscriber Service Card.

VARIABLE INCREMENT COMPUTERS—An 8-page bulletin on GEVIC—General Electric's variable increment digital computer, is available from General Electric Co. It describes what GEVIC is, how it operates, how it is applied to high-performance weapon control; guidance and navigation application in air and space vehicles, missiles, and portable surface-based equipment.

Circle No. 202 on Subscriber Service Card.

GAS TURBINE ECONOMICS—The economics of gas turbine power generation for U.S. Defense sites and for commercial applications are discussed in new Bulletin 202, just issued by Clark Bros. Co. A comparative analysis of gas turbine, steam, and diesel generating plants is made which points up the unusual economic advantages of the gas turbine plant, for both stationary and mobile installations. Major factors such as installed cost, fuel, operating cost and the time value of money are thoroughly reviewed with the help of charts and graphs.

Circle No. 203 on Subscriber Service Card.

TEMPERATURE PROBES — Catalog No. 66030, containing illustrations, specifications and descriptive material on precise platinum temperature transducers (probes) is available from Rosemont Engineering Co. Thirty-six different aerodynamic, immersion and surface temperature types are catalogued.

Circle No. 204 on Subscriber Service Card.

INSTANT FLIGHT

Varied stresses of programmed flight will soon be duplicated at ground-level. A $10 million static test facility, designed by Vitro for the U.S. Air Force, will shortly begin operations at Wright-Patterson. Here, major components will be subjected to programmed aero-dynamic heating and dynamic loading of supersonic flight. ■ In eleven major Vitro projects, the precise simulation of unusual environment was vital; twenty-one Vitro projects required design of nuclear containment. This is Vitro know-how.

Vitro

RO ENGINEERING COMPANY / A Division of Vitro Corporation of America / NEW YORK • WASHINGTON • LOS ANGELES / OVERSEAS: GENEVA • MILAN • BOMBAY

Why 17 Companies paid 50% above the original cost for a used IDEAL TEST TABLE?

We know from the virtual Who's Who in Industry that makes up our customer list, that our test tables have been highly regarded for a decade or more. Particularly in and around airline overhaul facilities and by airframe and missile manufacturers. Yet, it made us as perplexed as a pickpocket in a nudist colony when we learned that a volume distributor listed some 8 year old tables of ours in his catalog at 50% above what spanking new ones are selling for. And he sold 17.

Sure the old tables worked fine, but at that price they should have been as popular as raisins with legs.

If you are interested in the finest in azimuth rock and tilt test tables with the tilt angle of your choice, *call us.* Several rates and several speeds in both bench and floor models available.

Only one thing, though. We refuse to sell them for more than the reasonable list price. Immediate delivery. Write for free catalog.

Model 1411—Roll-Pitch-Yaw Test Table
0° to 15° from horizontal, 6 cycles per minute (standard), automatic reversing of direction of motion can be set from one to twelve cycles; table motion symmetrical. For testing all Gyro-Directional instruments, and limbering up runs on Gyro-Horizon indicators and for Automatic Pilot Control units. **$345.00**

IDEAL AEROSMITH
a division of ROYAL INDUSTRIES, INC.
3913 EVANS AVENUE CHEYENNE, WYOMING

Circle No. 11 on Subscriber Service Card.

Readers Respond

(Continued from page 12)

peded willy-nilly and want to duplicate the same thing. Let's tell the whiskers "Go ahead and explore the moon, or Venus or Mars. If you find a new and liveable planet we hope you *all* go out there. It will solve most of the world's problems. Meanwhile we are going to stay home and utilize the funds we'd have to throw away on this "outer space race" for bolstering our conventional military forces to maintain the strongest possible position here on the home planet."

I feel certain that a bill of comparative costs—Russia's costs versus our costs in the "outer space race" field—would be a shocker. General Trudeau once stated that the cost of the modern tank to Russia is the equivalent of 2000 pairs of shoes, whereas our cost for the same item is equivalent to 10,000 pairs of shoes. How much greater the ratio must be in these monstrous missiles swarming with high-paid personnel!

I view the "outer space race" as a potential gambit on the part of our chess-playing enemy designed to weaken us on *this* planet and featuring effects in the military, economic and psychological fields. After all, the doctrine of Lenin is explicit in calling for control of this world, not Venus or Mars, etc. Every billion dollars we throw away trying to go to the moon is a debit against the fixed amounts available to us for keeping our conventional military surface forces strong. The Army, Navy, Marine Corps and Air Force are each doing without many things they know they should have to be truly superior; therefore they could use saved funds to the very real advantage of our country. Our government has held the line on inflation by spending within its income and this has been the foundation of our strength. But it means a limit to available funds. Let's not let our enemies stampede us into throwing these hard-earned dollars into space needlessly. We must use them with great care down here on the surface of the planet the Communists swear they are going to conquer.

(Name withheld on request)
Monterey, Calif.

For More Direction

The opinions which I put forth below are strictly my own and do not necessarily represent the opinions of my present employer, Rocketdyne.

Of greatest importance, in my opinion, is the re-establishment of the decision-making machinery in the United States Government. This should come from the Executive Department and should be directed by the President.

The key items in your proposals are: clear-cut directions, courage, and conviction to support these directions even in the face of criticism which by necessity will be apparent when large numbers of people are involved.

Looking at your proposed space program, I feel that you have picked rather isolated projects which in themselves co tradict the primary goal that you w after; namely, the establishment of *strategic programs* in space. I would li to cite the example of the X-1 Aircr which was successfully flown superso for the first time in 1947. Howev as of this date we do not have a sup sonic long range striking force in op ation. Now, there is a big step betwe an isolated space supremacy accompli ment and an *operational* space striki ing force, which I can envision co be modelled somewhat after our pres SAC Air Force. I feel that any timetal should stress the *operational* date of su a force. If we follow this approach will then have the capability to acco plish specific space missions for politi and prestige purposes which the Russia have so ably exploited in the past. will then not be faced with having to pend on single space shots in the expe mental stages which will never guaran technical accomplishment and politi supremacy.

Another item I would like to co ment on is the subject of defense fu ing. It is obvious that this country cann afford to develop weapon systems in areas that all people might conceive be needed. The decision-making proc of the Executive Department should strengthened to encourage the lower ec lons of the Government to concentrate areas where we have the most capabil maximum technical advance within shortest period of time. In other wo the way to a successful fiscal policy an organized and concentrated direct of effort.

It becomes inevitably necessary to the incentive method back into the fense business. It may well be that a nu ber of Government agencies and industr organizations presently engaged in the fense business may fall by the waysi but if we are to survive we should business only with those industries agencies which will give us the most fective weapon system for our doll and develop and accomplish a given t within the time span specified.

Proposals, as you mentioned, are c troversial and can include many m goals than you put forth in your 2nd p posal. However, a service is being r dered to your readers and my perso opinion is that editorials of this nat are constructive and helpful.

Richard F. Gomp
Edwards AFB, Cal

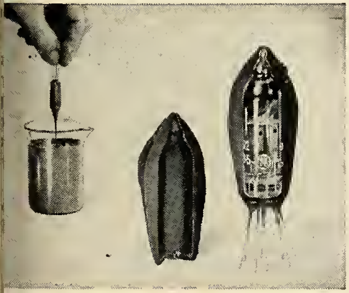
Stressing Sea Bases

I would like to present my own vi on what I think is a sound approach guaranteeing our survival. We must troduce a program of expediency in reg to production emphasis of our wea system programs. Such a program wo put all the production effort on those tems having the best chance of surv in the event of sustained warfare; and tems which do not offer the chance long-term survival even after many mo of war would be cancelled as being m ginal in potential value. The except

General Electric Silicone Rubber finds dozens of uses in missile systems. How many more will prove vital?

General Electric silicone rubber has the thermal toughness" to stand up under he searing heat of rocket blast-off or possible atomic attack. Add very good elecrical properties and excellent resistance o aging, weathering, moisture, flame, zone and corona and you can easily see hy silicone rubber is now being used in irtually every U.S. missile and space ehicle.

Since both space technology and silione rubber are relatively new, General lectric believes there are many more reas not yet explored where silicone rubers can help keep a missile functionally eliable and combat-ready. To help deigners in their evaluation work, we list ere the principal properties and appliations of G-E silicone rubber.



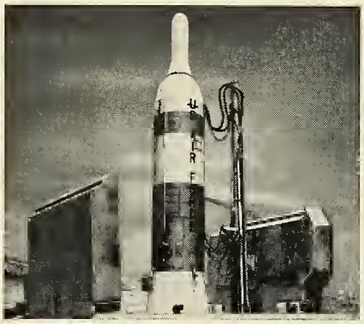
TV LIQUID SILICONE RUBBER — One of he most versatile materials developed in ecent years, RTV is a liquid rubber that ures at room temperatures. Like all silione rubber, it remains flexible over a ide temperature range and is virtually geless. Since it comes in a wide range of iscosities, it can be poured, sprayed, ipped, painted or applied with a presure gun or spatula. It bonds tightly to etal when a primer is used. When not rimed, you can readily remove RTV and hen reapply more. You can impregnate ghtly wound coils with RTV or form ctions several inches thick.

You can control cure time from two minutes to 24 hours. These are RTV's typical properties:

Viscosity	from 120 poises (very pourable) to 12,000 poises (paste)
Specific Gravity	1.2 to 1.5
Solids Content	100%
Shrinkage	0.2%
Heat Resistance	from —90°F to 600°F, and as thermal insulation, in 5500°F flame for minutes
Ozone Resistance	Comparable to Mica
Electrical Properties	See last table

Applications—RTV is used as a high temperature structural sealant in missiles, satellites and space vehicles. It is used to pot and encapsulate electronic components and assemblies for electrical and heat insulation and for protecting delicate components from physical damage. It is commonly used as an impregnating insulation in transformer coils, to pot and hold cable in raceways and to pot cable breakouts. You can make flexible molds with RTV and hence make accurate, duplicate castings from originals.

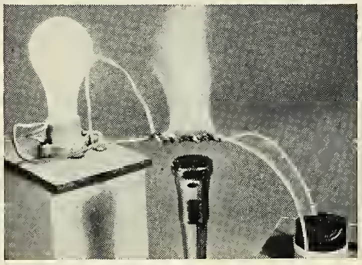
RTV is an excellent thermal barrier and as such is applied on and around missile nozzles. Tests show RTV's resistance to flame temperatures as high as 5500°F for several minutes. RTV also functions as a flexible ablative material and is used around probe holes, along raceways, and between stages and structural joints on the missile skin.



HEAT CURED SILICONE RUBBER PARTS —Silicone rubber gaskets, port seals, O-rings, shock mounts and other mechanical parts are not only used on missiles but have wide application in ground support equipment. For instance, missile silo doors use silicone rubber seals that will stand up to outside weathering, ozone and abuse for years and which will also resist the heat of missile launching and nuclear attack. Silicone rubber also resists brief exposure to cryogenic materials.

Silicone rubber has long-lasting temperature resistance from —150°F to 600°F, with excellent electrical, weathering, ozone, corona, radiation and nonaging properties at these temperatures. High tensile strength and low compression set are also within its range of desirable properties:

Tensile Strength, psi	800—1500
Elongation, %	100—600
Hardness Durometer (Shore A)	25—80
Compression Set, %	10—80
Tear Resistance lb/in	40—200
Radiation Resistance	1 x 10^8 roentgens
Electrical Properties	See table below



WIRE AND CABLE INSULATION — The long term reliability of silicone rubber when operating in high ambient temperatures and when current over-loads cause the conductor to approach 500°F is an important feature of silicone insulation. In an 1800°F flame, specially constructed silicone rubber insulated cables will continue to insulate for hours, forming a non-conductive ash that gives off no toxic fumes. And short term reliability is obtained even when silicone rubber is exposed momentarily to a direct flame of 5500°F.

Because of this excellent heat resistance, more current can be carried than in conventional cable (or smaller cable can be used). Other features: best compression set of all elastomers at temperature extremes, so that silicone rubber wire and cable does not deform under clamps; high ozone, corona, radiation and weather resistance, low moisture absorption, flexibility down to —100°C. These are the typical properties:

Volume Resistivity	10^{15}—10^{16}
Dielectric Strength, volts/mil	600—650
Dielectric Constant, 60 cps	3.0
Power Factor	.0010—.0050
Radiation Resistance	1 x 10^8 roentgens
Physical properties	Similar to table above.

Applications—Wiring harness made of silicone rubber insulation is often found throughout missiles. Cable offers added reliability for use in various places throughout the launch complex below ground from power plant to silos. All combat vessels built for the U.S. Navy during the last ten years, including fleet ballistic missile submarines and the new nuclear-powered cruiser and aircraft carrier, have silicone rubber insulated cable installations in all fixed wireways. In every case, silicone rubber is chosen because it is virtually non-aging, stands up to intense heat better than any other flexible insulating material, and continues to operate even when subjected to fire.

●

There are many more places where G-E silicone rubbers' inherent properties can be vital in missiles, satellites and space vehicles. For further data, call your nearest G-E sales office or write Section 01033, **Silicone Products Department, General Electric Company, Waterford, New York.**

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GENERAL ELECTRIC

would be those cases involving stop-gap systems designed to be immediately available for a short time, until high-survival-probability systems can be made operational.

I would propose the following modifications to your nine-point proposal:

Under Point 4:

Establish military commands on the basis of function—namely "Strategic Forces" and "Internal Security Forces." There is no need for any others. The strategic forces would include in their command all Naval forces, the elements of SAC and TAC, the Marine Corps, and Army elements which now consist of STRAC, the airborne and the special forces units such as the Rangers and the so-called "Special Forces."

These "Strategic Forces" would be adapted to a mobile base concept, these mobile bases would consist primarily of ships and submarines, which would be capable of acting as bases for the strategic forces for a year or more without coming into port. This idea is not as far-fetched as it sounds. I cite as examples the Little America operation in the Antarctic and the long duration of whaling ship voyages, even in times far past. Naturally, ships would not be able to do all of it, and mobile land bases would have to be worked out, using off-the-road vehicles and the railway systems of North America. In the event of brush-fire wars, the strategic forces would serve the functions of tactical forces.

The "Internal Security Forces" would be charged with the serious responsibility of preserving the internal security of the U.S. and her citizens against all enemy action, including sabotage. These duties would include: setting up detachments of Army troops around all population centers to organize the defense of our cities against invasion and to assist and direct the evacuation of civilians, the care of wounded, the control of damage after an enemy attack. In addition, the internal security forces would man the radar systems, antimissile systems and other weapon systems or devices which would be needed to counter enemy attacks on our homeland itself.

Under Point 5, I feel that spending should be directed as follows:

a) Place the *Polaris* missiles and submarine production systems on a crash, 24-hours-per-day, seven-days-per-week basis. Air Force claims to the contrary notwithstanding, this is the first system that can deliver us invulnerable missile-launching capability and high reliability in any sort of quantity.

b) Place the new tactical bomber on the same sort of crash program. In addition, develop the new longer-range, short field bomber as a shipboard aircraft so that it can be integrated into our shifting carrier—air bases at sea.

c) Place the new weapons and equipment for our ground troops on a crash production program similar in nature to *Polaris;* however, heavy tanks should r be produced.

d) Accelerate the B-70 developme and produce a small number of them soon as possible. Do not place this pla in volume production unless it can given a short, dirt field capability w runways under 5000 ft.

e) Greatly accelerate *Dyna-Soar* a develop it with an eye towards a weap system which in *final form* can be *launch* and *recovered* by highly mobile syste *at sea.*

f) Initiate a highly accelerated p gram to launch and recover satellites fr sea-going systems.

g) Cancel the *Minuteman* weapon s tem, for the same basic reasons that t SM-62 *Navaho* was cancelled—name that by the time it's ready a superior s tem will be operational.

h) Place the production of hunt killer submarines on a crash progra These subs are vitally needed to prot *Polaris,* screen our carriers, and tra enemy subs which would launch missi against our country.

i) Start working out railway-bo airfields. Such a system will augment c carriers and be the means of maintaini and launching our new intercontinen tactical bomber and possibly an ST B-70 with lift-fans from short strips l out at railside.

j) Place the Navy's new Missileer a craft on an accelerated program.

k) Greatly accelerate all antisubmari warfare R&D—and the production systems.

l) Augment our manned aircraft n bile base capability with either more c riers or a submarine launch-and-reco system. Either of such systems would built around the new tactical bomber. T sub idea is not far-fetched—the Fre had a plane-carrying sub prior to Wo War II, and the Navy has launched planes such as the Regulus from subs.

m) If railways could be the means preserving the life of a missile or pla then they should be able to preserve lives of our citizens. Accordingly, pl should be made to use railways to perse our citizens in event of war.

n) Largely reduce and taper off efforts with the liquid-fuel *Titan* and *A* missiles. No new starts on bases should made. These systems for one reason another are dragging their feet, and th launchers are ultimately vulnerable, as the *Minuteman's.*

o) Develop a super-*Polaris* to repl the big-warhead, land-launched liq rockets.

As a last word, I would like to that carriers and other surface vessels have a good chance of survival provi they do not approach the proximity the enemy's land mass until his defe have been considerably reduced by mis bombardment, and also provided that t hide from the enemy's subs or are able be well defended by the antisubma systems.

Strategy which is based on harde bases will not work.

George B. Willi
Cincinnati

If interested and qualified, please forward your resume to Mr. J. E. Goode, Assistant Chief Engineer, P. O. Box 748M, Fort Worth, Texas.

In preparing for the challenge of aero/space in the 1960's, Convair/Fort Worth is expanding in the field of sensors, guidance and control, reconnaissance techniques, data processing, and electronic systems. We are looking for imaginative and creative specialists capable of evolving advanced concepts and techniques both analytically and in the laboratory.

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;E's Defense Magazine

Your excellent "Modest Proposal" to [r. Nixon and Mr. Kennedy states em-natically that "the people of the United tates desperately need to know where ey stand, where they are going. More ian anything they need to have objec-ves." In short, there must be greater ıblic understanding of U.S. defense—ot only in regard to space matters but in gard to all defense questions.

With this assertion we could not agree ore completely. The purpose in General lectric's founding of its own magazine, *he General Electric Defense Quarterly,* precisely to further this objective of eater understanding of U.S. defense atters, with the belief that defense nderstanding is a wholly non-partisan fair. The magazine's current issue, pub-hed this month, has as its theme "Public nderstanding and U.S. Defense."

J. B. Stroup, Defense Business
Information
News Bureau
General Electric Co.
Schenectady, N.Y.

iscal Balance First

As a rebuttal to your open letter to e Presidential Candidates, let me make e following points:

1. The present administration has not nored the existence of a Space Race th the Soviet Bloc. Rather, under this ministration we have made substantial ides forward in the field of ICBM's and BM's. Although we do not have the ectacular successes exploited so well by viet propaganda, our results with *Atlas,* *laris* and *Titan* are not minor advances the Space Race.

2. You encourage increasing the ICBM, *laris* and B-70 efforts to a maximum gree with utter disregard for budget ilings. Not only is this bad business, t history is replete with accounts of litarily strong, fiscally weak nations ich have gone down to ruin. I agree at we must continue to spend as much possible to keep us in the Space Race, t let's not encourage this sort of thing the expense of other governmental mmitments such as welfare, education, ., and especially let's not obtain our ace ascendancy at the expense of a ficit economy.

3. I wholeheartedly concur with Item of your proposal, which recommends eamlining of defense regulations. This a field in which I feel we can gain in onomy as well as effectiveness.

Finally, it is good to feel that we in missile field are important to our vernment and to the ways of advancing ence and peace. I agree with you com-tely on that comment. But we cannot get that we are only a part of the eam" and that, as "Captain," the presi-at must be aware of, and balance, all factors in order to win the more im-tant ideological race between com-nism and free democracy.

O. R. Cutler
Salt Lake City

when and where

OCTOBER

IRE, AIEE, ISA 13th Annual Conference on Electrical Techniques in Medicine and Biology, Sheraton-Park Hotel, Washington, D.C., Oct. 31-Nov. 2.

1960 Fall Radio Meeting, sponsored by Electronics Industries Association, Engineering Dept. and IRE Professional Groups, Hotel Syracuse, Syracuse, Oct. 31-Nov. 2.

NOVEMBER

Conference on Electrostatic Propulsion, ARS and U.S. Naval Postgraduate School, Monterey, Calif., Nov. 3-4.

Government Contracting Course, NDEI, sponsored by NSIA and Harbridge House, Inc., Dayton, Nov. 7-18.

First National Die Casting Exposition and Congress, Society of Die Casting Engineers, Detroit Artillery Armory, Detroit, Nov. 8-11.

National Convention, National Aeronautics Association, Indio, Calif., Nov. 14-16.

Sixth Annual Conference on Magnetism and Magnetic Materials, sponsored by: AIEE, American Institute of Physics, ONR, Institute of Radio Engineers, American Institute of Mechanical Engineers, New Yorker Hotel, New York City, Nov. 14-17.

IRE Mid-American Electronic Convention, (MAECON), Hotel Muehlebach, Kansas City Mo., Nov. 14-16.

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editorial . . .

Nixon Drops Party Line on Space

VICE PRESIDENT NIXON'S reply to the MISSILES AND ROCKETS open letter to both candidates, asking that they declare their stands on the defense and space issue, is notable in that on two major points of the issue he differs sharply from the Eisenhower-Administration line.

It is also notable in that it marks the first time Candidate Nixon has made known publicly and clearly his feelings and opinions on the U.S. defense and space exploration posture *vis-a-vis* that of the Soviet Union.

In replying to Point One of our nine-point proposal to gain parity or better with the Russians in defense and space, Mr. Nixon said:

"The Eisenhower Administration long ago recognized we were in a strategic space race with Russia. Today we are ahead."

On Point Three, proposing that the United States must insure "freedom of space" before we can guarantee "space for peaceful purposes," the Vice President declared:

"Freedom of space, like freedom of the seas, is essential to the progress of mankind. *Our military forces must have the mission and the necessary strength to defend freedom of space.*"

Actually, the Eisenhower Administration, to our knowledge, has never recognized that we are in a strategic space race with Russia. *It has never admitted we are in any kind of a space race with Russia.*

In fact, the Administration has on several occasions gone out of its way to deny or refute such a suggestion. On several occasions, it has declared that we are not in a race in order to explain why our achievements, while greater in quantity than the Russians, are of lower strategic quality.

On Point Three the Administration has frequently brushed off lightly the suggestion that the military services had a right or a need to be in space. Publicly, at least, the fact that freedom of space may not come from wishful thinking has not been recognized.

As recently as Sept. 22, in his address to the United Nations, Mr. Eisenhower proposed that space, like the continent of Antarctica, be declared "off limits" to military preparations.

The key word there, perhaps, is "preparations." We suggest that we are already prepared to defend the freedom of Antarctica should it be threatened. We are not, but we must be, equally prepared to defend the freedom of space should it be threatened.

WE ARE GLAD to record Mr. Nixon's stand on these two points—as on the others in the nine-point proposal. We are glad to be the medium to bring his views into the open, as we previously published the views of Senator Kennedy.

We doubt that the public fully understands the vital implications of the competition with Russia in the defense and space areas. Or understands that the two—defense and space—are rapidly becoming one and the same, and that the outcome of this competition may decide our survival, both as individuals and as a nation.

It may be that the complexity of the issue has prevented more complete debate. Certainly it is not that the issue lacks importance. Nor do the views of the candidates, as we have presented them.

Clarke Newlon

TO SPACE AND BACK!

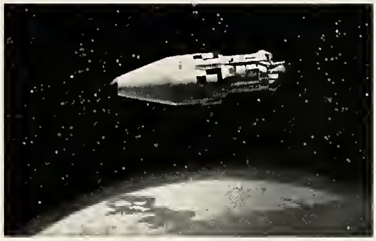
America's Agena is first orbiting satellite to send a capsule back from space

On August 11 a Lockheed-built Agena satellite gave America a monumental "first" in the race to conquer space. With perfect timing, it dropped its payload into a recovery area near Hawaii.

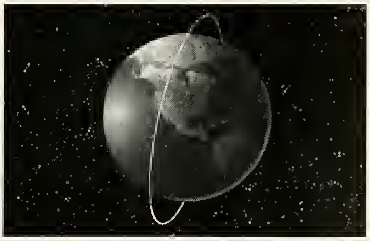
This brilliant feat, verifying the recovery technique, could not have been accomplished without the spadework already done by earlier Agenas in the Discoverer program of the U.S. Air Force. The Agena was first to be put on a predetermined orbit, a nearly circular orbit, and the difficult polar orbit; first to be commanded, monitored, and maneuvered on orbit; first to stabilize itself at an exact angle to earth; first to eject a recovery capsule. But the Discoverer program's most important achievement has been to provide the Air Force with a tested satellite for its vital Midas and Samos programs.

A larger, more powerful version, the Agena B, will be used in the satellite, lunar, and deep-space programs of the National Aeronautics and Space Administration for several years.

After first-stage Thor booster dropped away, Agena satellite's own rocket engine ignited and ove it to exact speed to reach its planned polar orbit.



2. As soon as it reached its orbit, the Agena satellite swung itself around 180°, so that it sped tail first on its 18,000-mph, 94-minute journey around the world.



3. During the Agena's 17th pass around the earth, a timing device triggered gas jets that tilted its nose downward to a 60° angle for ejection of re-entry vehicle.

After the vehicle's retro-rocket (see main illustration) had slowed it to a safe re-entry speed, a parachute lowered the 300-pound capsule to recovery area.

5. Agenas are made at "Satellite Center, U.S.A."—headquarters of Lockheed's Missiles & Space Division at Sunnyvale, California. Lockheed is prime contractor for the Discoverer program. Subcontractors are the General Electric Co. (recovery capsule), Bell Aircraft Corp. (Agena engine), and Douglas Aircraft Co. (Thor booster).

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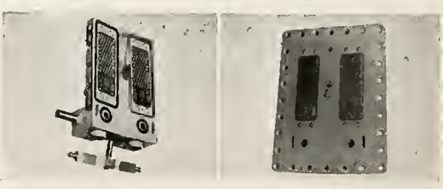

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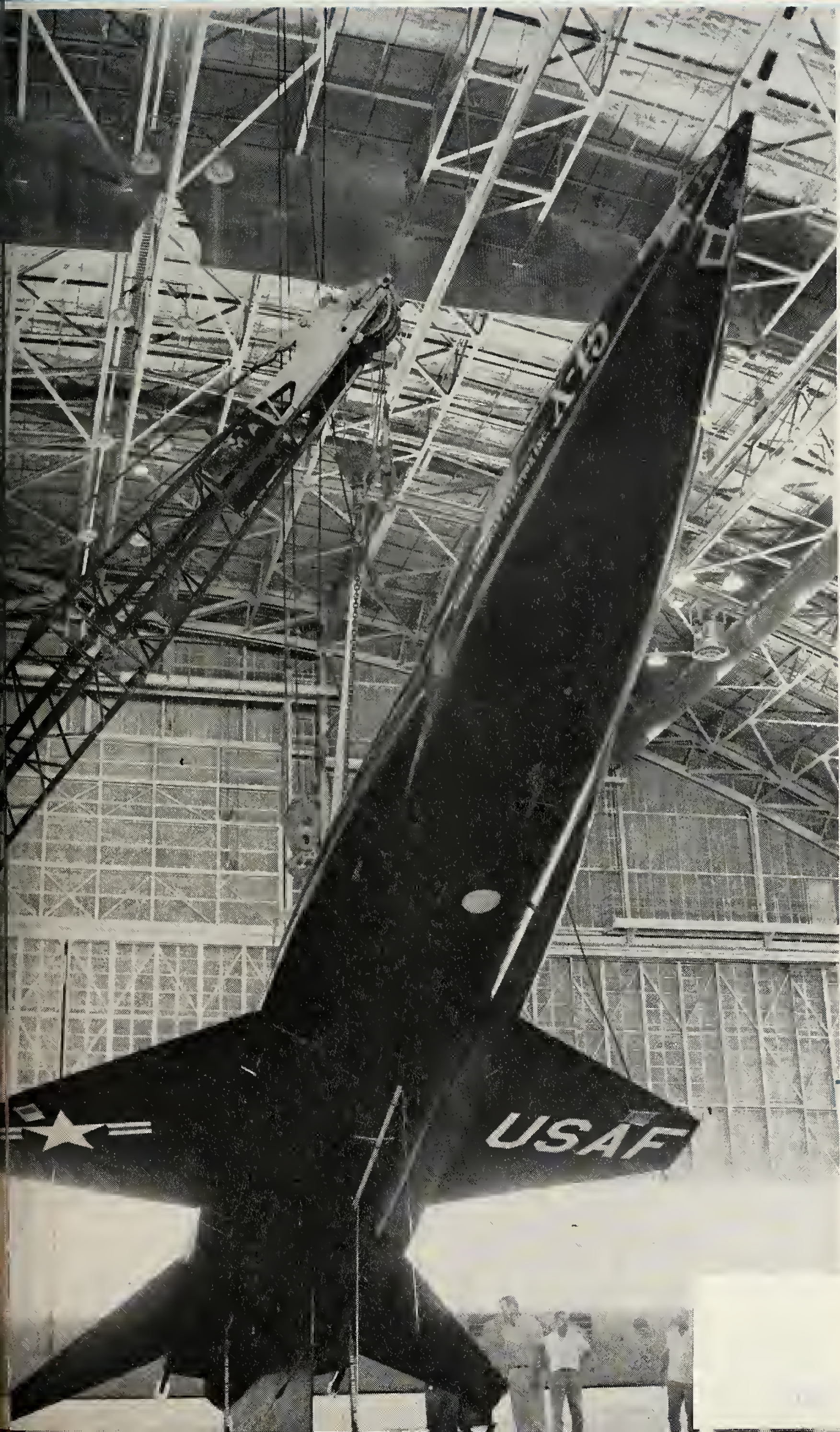

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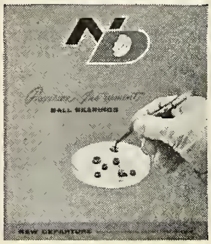

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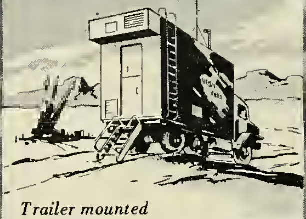
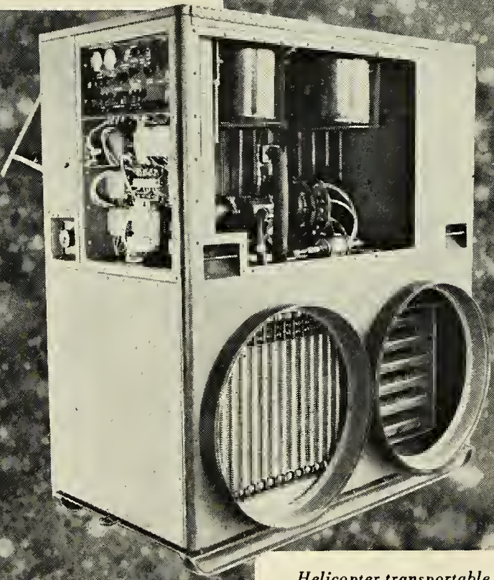


Trailer mounted refrigeration unit, 5 tons capacity



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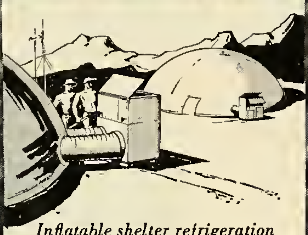
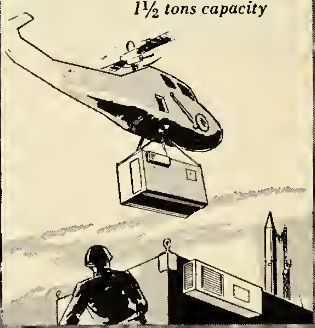
- A brochure describing AiResearch ground air conditioning systems may be obtained by writing to Environmental Controls Project, Los Angeles Division.



Inflatable shelter refrigeration unit, 7½ tons capacity (unit shown above)

Helicopter transportable hut refrigeration unit, 1½ tons capacity



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THE COVER

X-15 gets balance checks in NASA hangar at Edwards AFB, Calif., after new XLR-99 engine was installed and prior to flight tests of its operation. See p. 38.

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The Countdown

WASHINGTON

using the B-70

Unless the next Administration switches signals, the B-70 Mach 3 bomber will be another "fly-before-you-buy" *Zeus*-like program. There will be probably only 12 operational prototypes produced, even with the new stepup in funding. COUNTDOWN hears, furthermore, that no work is being done to allow the B-70 to carry ALBM's —even though that was a major justification for the bomber as a weapon system. Significance: only the B-52 now will be available to launch the *Skybolt* ALBM, and B-52's are expected to become obsolescent by 1965-66—leaving no ALBM carrier.

BR Funds Sought

The Army is hoping for a large increase in the FY '62 budget to boost funding of chemical-biological-radiological warfare. If it gets the money, it will push development of large CBR warheads for existing missiles.

e'd Like to Stay

In advance of election day, NASA Administrator T. Keith Glennan was telling friends he would like to stay in Washington—working for the next administration. If elected, Sen. Kennedy presumably would put his own man in Glennan's job, while Vice President Nixon might be willing to keep Glennan on. But Glennan is willing to take some other government science job, if asked.

echnical or Political?

NASA officials are insisting the two *Mercury* shots on Nov. 7—election eve—fell on that date for "technical" reasons, not political. Some critics are charging the lofting of a final *Little Joe* prototype capsule from Wallops Island and the first *Mercury-Redstone* from the Cape were programed to boost Vice President Nixon's arguments about U.S. prestige just before the voters head for the polls.

INDUSTRY

ore B-70 Contracting

North American Aviation says the release of $155 million to the B-70 bomber program definitely will mean the reinstatement of some subcontracts. Just how many probably will be known in another week. Contracts to IBM, Westinghouse and Motorola already have been reinstated. Where the pinch will come, however, is in areas where the state of the art already has been advanced in the year since the program was "reoriented." Several sub-contractors may be affected.

oost for PMR

Navy has issued Federal Electric (an ITT subsidiary) a $9.4-million contract for PMR range operations over the next three years. Contract covers radio, telephone, teletype, photography, optical and radar tracking systems as well as recording and information display equipment. Included in the award are subcontracts to the Pomona Division of Marquardt and Eckerts Inc., Lompoc, Calif., for some ordnance and ground safety work.

Shades of the Past

Memory of a *Polaris* engine which tore loose and flew four miles several months ago to become the first "interplant" missile is prompting Aerojet to put destruct packages in the Project *3059* rocket for static tests. The AF *3059* is a segmented solid rocket of over 1 million lbs. thrust.

Surveyor Proposals Due

Industry proposals for NASA's Project *Surveyor* lunar soft-landing vehicle are due at Jet Propulsion Laboratory Dec. 15. Hardware contract award is expected about 60 days later.

Spread of PERT

Major weapon systems now adopting the computerized PERT (program evaluation and review technique), developed to manage the *Polaris* program, now include the Air Force's *Dyna-Soar, Skybolt* and *Minuteman* and the Army's *Nike-Zeus.* Several hundred contractors soon will be reporting progress under the system.

Modern Super Scout

NASA is planning to develop a modern propellant for the first and second stages of *Super Scout,* its solid space booster. Uprating should give the vehicle an orbital payload capacity of 250-300 lbs.

Front Office

Lockheed is intensifying its ASW capability with a new corporate-wide organization designated "Antisubmarine Warfare and Ocean Systems." Headquarters will be at Burbank . . . Douglas is setting up a new Astropower Inc. division to work on exotic propulsion systems . . . Chance Vought is dropping the "Aircraft" from its corporate name . . . Nine months earnings by Boeing ($16 million on sales of $1.2 billion) are nearly double 1959.

INTERNATIONAL

Japanese Testing MAT

Sixth prototype of Japan's *MAT* anti-tank missile is being tested this month. U.S. military officials are attending the firing, but say it's too early yet to finally evaluate the usefulness of the weapon.

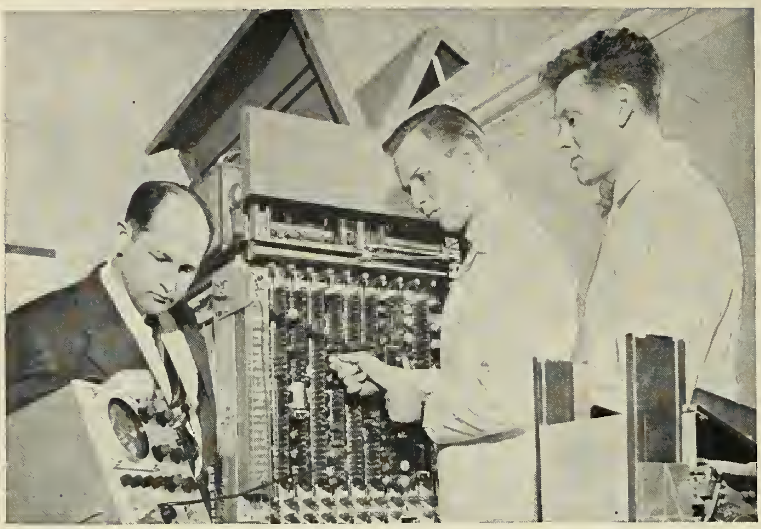
French Debate Space Program

In about a month the French Parliament will start debating legislation which includes appropriations for launching a satellite. New element in the debate will be whether to accept an invitation to join the "space club" Great Britain is trying to get together.

Tortured Thought of the Week

If the Russians refrained from trying a space spectacular during the windup of the U.S. presidential election campaign, did it have any significance? Some foreigners are wondering whether it would mean Khrushchev really favored Nixon by not adding new fuel to the Prestige Gap debate. Or whether he really favored Kennedy and thought a shot might have a reverse affect on voters and elect Nixon.

AT UNIVAC . . .



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letters

Trudeau Interview

Secretary Brucker was pleased ind with the recognition which the Oct. M/R gave to General Trudeau and Army's Office of the Chief of Resea and Development.

On behalf of the Secretary, please cept his sincere thanks and his best p sonal wishes.

John G. Hill, Jr.
Lt. Colonel, GS
Military Assistant to
Secretary of the Ar
Washington

First for Science Fiction

Arthur C. Clarke was kind enough send me a copy of his letter to you (M/ Oct. 24, p. 9), and I thought you mig like to know that I agree with its conten I believe that space radio relays, if n earth satellites, were described in scien fiction even earlier than 1945.

J. R. Pierce
Director of Research—Co
munications Principles
Bell Telephone Laboratorie
Murray Hill, N.J.

Polaris Flight Simulator

I refer to the article which appear in Missiles and Rockets (Aug. 29, 26) on the development of the Flig Simulator which helps speed the *Polar* program.

I am a careful reader of M/R— are most of my friends in the industry and felt that the article was well don quite penetrating, and illuminating— are most of those which appear in th publication. Your batting average is f above Mickey Mantle's.

Best wishes for continued success.

Bert W. Holloway
Corporate Director
Advertising, Publicity, Promotio
Lockheed Aircraft Corp.
Burbank, Calif.

P.S. Or anybody else's batting, either.

For Defined Space Roles

(Regarding the editorial, "The Aer space Strategic Force," M/R, Sept. 5

Now that the feasibility of large rocke boosters has been proven, the natio should alter its space vehicle plans to em phasize manned spacecraft rather tha booster systems. In recent years, apparen national policy has been to adapt spac payloads to requirements of existing o proposed booster vehicles. Couldn't w realize a significant program breakthroug by first determining our spacecraft re quirements for both military and civilia missions, and then developing on a par allel basis a suitable booster vehicle?

Use of a single manned spacecraf operating in orbital flight conditions coul ovide multimission capabilities, such as rveillance, communication, meteorolog-al and astronomical observation. A vari-y of present and proposed costly un-anned systems would be replaced by a ngle, maneuverable and recoverable anned system. Experience gained in or-tal and suborbital flight would provide aportant data for planetary re-entry hicle configurations.

During the flight test phase of the acecraft development program, concur-nt captive and flight testing of necessary terplanetary booster systems could be complished. Flight testing of the "new" acecraft would be accomplished using isting booster systems during the in-rim period.

For example, the recently announced *pollo* space ship project would have been arted before the *Saturn* C-1 and C-2 poster vehicles with suborbital flights ac-mplished by use of existing boosters. In her words, to provide a suitable and re-able manned spacecraft that would be ailable for space missions at a time co-cident with suitable booster availability, e *Apollo* vehicle is at least *three years hind schedule* today.

There is no better time than now to re-nsider our national space objectives. We ave just two choices if we intend to con-nue space exploration: (1) Continue to lapt unmanned payloads to existing poster systems, or (2) develop manned stems and tailor booster vehicles as re-uired on a parallel basis. The relative na-onal priority of manned space flight nder the former choice is low at best. he latter choice provides the one in-edient lacking in our present program—nphasis and priority for manned systems.

It is conceivable that impetus for anned space vehicle development could aterialize if the military services and ASA were given the following roles and issions:

Army—Tactical and strategic bombardment using *all* guided and unguided missiles launched from land.

Navy—Tactical and strategic bombardment using *all* guided and unguided missiles launched at sea.

Air Force—Tactical and strategic bombardment using *all* manned aerospacecraft, and *all* space exploration.

NASA—Technical direction and development of *all* military and civilian space boosters and spacecraft to be used for space exploration.

The above plan has the advantage of oviding each service and NASA a ghly defined role within the national issile/space program. Specifically, the ir Force with its space exploration role ould provide the nation with its first non-dundant spacecraft development pro-am. Space systems developed under Air orce guidance could be used for either ilitary or civilian missions. The national ace program could be developed and oordinated by a single cabinet-level gov-nment agency, perhaps called the De-artment of Extraterrestrial Affairs.

Robert H. Jones
Research Engineer
Lockheed Missiles and Space Div.
Santa Cruz, Calif.

Engineering notes from the **SM/I REPORTER**

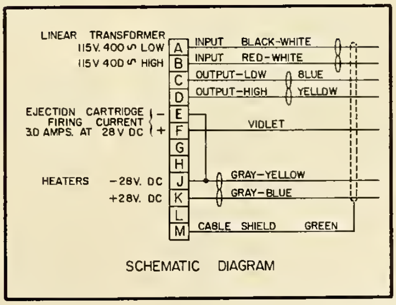
BY STANLEY M. INGERSOLL, *Capabilities Engineer*

Report No. 12
TV 2020 Ejectable Vane Angle of Attack Transducer

Precision built for stringent missile applications, the self-powered TV 2020 provides an AC output proportional to the direction of air flow surrounding a vehicle. The ejectable vane, an optional feature, is affixed to the shaft by calibrated shear pins. It may be ejected by a minimal explosive charge contained within the vane and initiated by an electrical impulse. A heater within the metal of the vane itself makes it invulnerable to icing. The vane arm, shaft and counterweight structure of the TV 2020 are stainless steel and its stable case and structure are cast aluminum. Silicone oil of relatively low viscosity is used as the damping medium. The vane arm is interchangeable and will work with any transducer of the TV 2020 type.

Typical Performance Specifications

Angular Range .... ±15°
Electrical Input .... 115 volts at 400 cps
Electrical Output .... 0.3 volts rms 400 cps per degree
Total static error (max.) .... Between +7.5° and −7.5° ±0.15°
between +7.5° and +15° ±0.45°
between −7.5° and −15° ±0.45°
Operating Mach Number Range .... 0.2 to 7.0
Operating Temperature Range .... −54° to +125°C.
Heater:
Power Requirements .... 250 watts
Operating Voltage .... 28 volts DC
Size:
4¾" diameter of mounting flange 4" deep
Total Weight .... 3 lbs., 5 oz.



TV 2020
ANGLE OF ATTACK
TRANSDUCER

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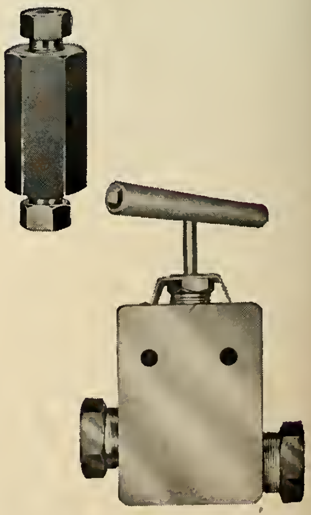
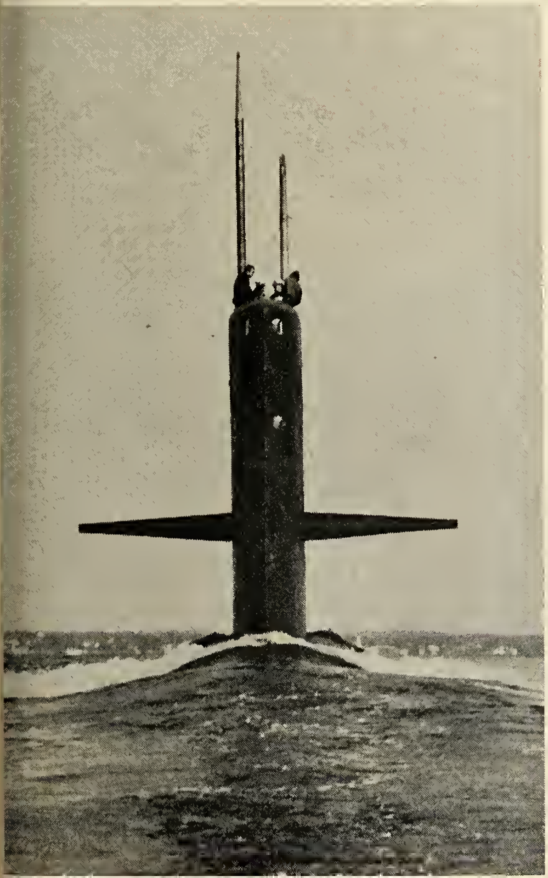


AMINCO

Why the Navy Suddenly Wants 100 Nuclear-Powered ASW Submarines

How much time is left to protect Polaris FBM submarines with the George Washington ready to head out on station? Are nuclear attack submarines the only answer to the threat raised by Soviet nuclear subs now a-building? These are just some of the problems bedeviling the Navy as it studies the need for creating a great underseas armada—soon. There are grave complications. Will Congress go along? What about the new Administration—when it gets a look at the $4-billion pricetag? Then there's the flattops—are they doomed?



UBMARINE MIGHT is demonstrated by the Skipjack, first f the Navy's high-speed, nuclear-powered attack submarines.

By James Baar

THE NAVY IS PRESSING for construction of a mighty ASW force of some 100 nuclear-powered attack submarines to guard the *Polaris* fleet and defend U.S. shores from underwater-launched Soviet missiles.

The time frame: By 1970. The cost: About $4 billion.

Powerful congressional support is already gathering behind the proposed program. In fact, some leading members of Congress regard the Navy's timetable as much too conservative.

For example, Chairman Clarence Cannon (D-Mo.) of the House Appropriations Committee is proposing that the Navy have 88 nuclear-powered attack submarines in commission by the end of 1968 and a total of 100 by the end of 1969.

Cannon and other members of the Appropriations Committee want the Navy to have completed a fleet of 45 *Polaris* submarines by the same time or sooner. This would mean that the Navy would build nuclear attack and *Polaris* submarines at a rate of approximately two to one.

• **Big step-up would be needed**—Any such Navy program would call for a great increase in nuclear submarine construction throughout the 1960's.

At present, the Navy has commissioned, launched, under construction or authorized but still on paper a total of only 27 nuclear-powered attack submarines and 14 *Polaris* submarines.

To construct a fleet of 100 attack submarines by 1970 the Navy would have to lay a minimum of nine keels a year for the next eight years. But during the current fiscal year, the Administration has refused to authorize the Navy to lay a keel for even one.

To construct a fleet of 45 nuclear-powered *Polaris* submarines by 1970, the Navy would have to lay about

FIRST POLARIS SUBS—George Washington (left) and Patrick Henry—tied up at pier.

1960 Nuclear Submarine Strength

Type	Commissioned	Launched	Building and Authorized	Total
Polaris-launcher (SSBN)	**3**	**2**	**9**	**14**
Attack (SSN)	**8**	**6**	**13**	**27**
Picket (SSRN)	**1**	..	..	**1**
Regulus-launcher (SSGN)	**1**	..	..	**1**

four keels a year. However, many in the Navy and Congress are calling for a much faster buildup based on laying a keel a month. So far, the Administration has been building *Polaris* subs at the rate of about three a year. For Fiscal 1961, the number has jumped to five. But the increase was made at the cost of previously planned attack submarines.

Supporters of proposals for a large fleet of nuclear attack submarines feel that events will force the new Administration—regardless of who is in the White House—to support a large increase in the building program beginning next year.

The events cited are primarily two: The sailing this month of the George Washington, first of the *Polaris* fleet, and the announced development by Russia of its own nuclear-powered submarines.

The George Washington and her sister ships will operate while on station as integrated parts of the U.S. Fleet. Specifically, this means that their hiding places will be guarded by both surface and undersea warships that will be on the alert for the approach of any unfriendly forces.

These operations will be conducted over a wide area as part of the Navy's ASW activities. But nuclear-powered attack submarines also may operate as picket ships working in close cooperation with each *Polaris* submarine.

The *Polaris* submarines are fully capable of defending themselves if necessary. However, particularly when the time comes that Russia has many nuclear-powered attack submarines, some Navy planners believe a *Polaris* sub and one or more attack subs may operate as a team. This would greatly complicate an enemy's attack problem.

• **Russian threat**—The building of a Soviet nuclear-powered submarine fleet is regarded by the Navy as a threat of momentous significance.

The present Soviet diesel-powered sub fleet of 450 to 500 ships was constructed at a very rapid wartime rate. This building slackened while the Russians developed a nuclear-powered sub. Now, a great speed-up is expected.

Besides attempting to seek out *Polaris* submarines, these new Soviet nuclear subs will be capable in a few years of challenging all seaborne lines of communications. Moreover, the Russians are expected to have their own version of the *Polaris* submarine in operation by 1965 at the latest.

Soviet Premier Nikita Khrushchev only last month boasted that he already has rocket-launching nuclear-powered submarines capable of launching missiles. Informed Navy sources believ that these subs are only capable o launching short-range *Komets* from th surface. However, longer-range *Komet* capable of being launched from submerged subs are known to be unde development.

• **Navy's answer**—The weapon tha the Navy wants for defense against th Soviet nuclear submarine menace is th new Thresher Class hunter-killer sub.

The high-speed Thresher is an improvement over the earlier high-speed Skipjack Class—first of the tear-drop Albacore hull subs capable of outrunning any surface ship afloat.

The Thresher Class sub displaces about 3750 tons and is 274 feet long. The bow is capable of housing very-long-range sonar equipment. Its four torpedo tubes are capable of firing not only the Navy's latest torpedoes but the deadly Goodyear *Subroc* Missile.

The nuclear-tipped *Subroc* — designed to be launched underwater, fly through the air and re-enter the water to strike an enemy sub—is expected to be operational in 1961. The missile is understood to have a range of better than 20 miles.

• **Money lacking**—The current cost of a Thresher Class submarine is about $57 million. The cost of the much larger *Polaris* submarines is about $100 million each.

In these figures, both certain to increase, can be read the fiscal dilemma of the Navy.

Even at 1960 prices, the construction of a 100-ship fleet of attack submarines will cost more than $4 billion. And, in view of the continuously upward trend in the cost of equipment, this figure is most conservative.

To begin a submarine-building program of this scope could only mean a sizeable increase in the Navy's budget or the deterioration of some other part of the Navy's forces.

• **Carriers obsolete?**—The Navy contends there is no major part of its forces that can be sacrificed without a decline in needed U.S. strength. But some of the most ardent supporters of a big submarine fleet disagree. Their target is the 300-to-450-million dollar super aircraft carriers that the Navy also contends the nation must have.

"Aircraft carriers have had their day," Representative Cannon said bluntly last June. "They have won their proper place in history. However, we are only starting to exploit the nuclear submarine . . . . The Soviets see this clearly—why not we?"

In short, Cannon and others argue that the missile-launching nuclear-powered submarine—not the carrier—is the Navy's ship-of-the-line in the second half of the 20th Century.

The Missile/Space Week

ussians, Laborites Balk at Polaris-on-Clyde

The Navy is preparing to establish its first overseas *olaris* supply base in Scotland's Firth of Clyde despite rotests from the Soviets and Laborite members of arliament.

Prime Minister Macmillan announced the advance ase would be located at Holy Loch on Scotland's ruged west coast within easy access of the Norwegian Sea nd the Arctic Ocean.

Under a U.S.-British agreement, the *Polaris* Tender roteus, a floating dock and auxiliary craft will be staoned in Holy Loch soon after the beginning of the ear. They will be there in time to service the George Vashington—first sub of the *Polaris* fleet. The big nulear-powered sub is scheduled to be on station with her 6 nuclear-tipped missiles somewhere in the Atlantic y November 15.

The Proteus will provide *Polaris* subs with food and ther supplies including spare missiles. The subs also ill use Holy Loch for changing crews.

Thirty-two Laborite MP's protested that the base ould present "grave dangers" to Britain. However, in lasgow two leading newspapers supported Macmillan nd the agreement.

-70 Bounds Back—Almost

The Eisenhower Administration's farewell FY 1962 efense budget is expected to include about $365 milon to $415 million for the B-70 R&D program. But e program still has money troubles.

The North American B-70 received a rejuvenating push this week with the release of $155 million by the Defense Department for resuming the program as a full weapon system project.

The extra funds—part of the more than $280 million voted for the B-70 by Congress over previous Administration objections—brought to $285 million the total funds available to the program in FY 1961.

This was a long way from the $75 million to which the Administration earlier this year sought to reduce the project. However, the total was still well below the $450 million originally sought by the Air Force.

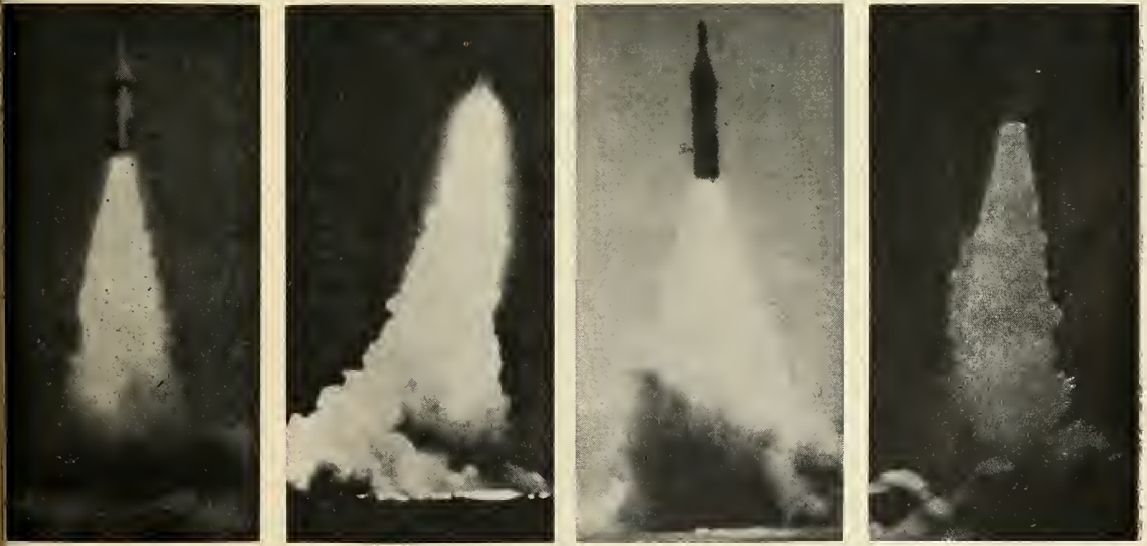
Furthermore, informed sources in the Administration made clear the B-70 remained on trial as a program and might never be produced for deployment.

Bendix Wins Major Role in Advent

Bendix Corp is responsible for a major share of the work on the *Advent* 24-hour communications satellite under a newly announced Army Signal Corps contract.

The half-ton microwave communications satellite will be placed in a 22,300-mile orbit that will enable it to remain over one point above the earth's surface. Ground stations will be built at Ft. Dix, N.J., and Camp Roberts, Calif., for the R&D program.

Bendix will be responsible for design of the active repeater satellite, special-purpose ground and checkout equipment and communication systems engineering. No money figures were disclosed, but the entire program is expected to cost about $174 million.



Patrick Henry Nears Combat Readiness

LARIS LAUNCHES from under the Atlantic in series four shots, day and night, simulated operational conditions. om left, first shot was Saturday afternoon, Oct. 15; second was Saturday evening; third was Sunday morning, Oct. 16; and fourth was early Tuesday, Oct. 18. Launches were from submarine Patrick Henry 500 miles east of Cape Canaveral.

paper design bypassed

Rover May be Put on Crash Basis

THE PROJECT ROVER nuclear rocket may become a crash program.

The National Aeronautics and Space Administration and the Atomic Energy Commission moved in that direction last week with a decision to bypass the normal paper design studies on the *Rover* nuclear engine. Instead, *Rover* will go directly into an industry research and development program.

Still hanging fire is the question of whether to build the *Rover* vehicle around the engine at the same time. Parallel vehicle development, which would make *Rover* a true crash program, presumably will be decided by the new President.

Harold B. Finger, chief of the joint NASA-AEC Nuclear Propulsion Office, last week ordered the speedup in *Rover* engine development, which could cut six months or more from the development schedule if NASA moves quickly on circulating and evaluating industry bids on the engine development. He cancelled plans to award one or more contracts for six-month paper studies of engine design.

The current NASA timetable calls for flight-testing *Rover* as an orbital stage by 1965, and completing ground tests of the engine by 1963. Finger told M/R no decision has been made on the timetable for industry participation in vehicle development. He would not rule out the possibility that it might begin within a year, an obvious indication that it conceivably might be included in the Fiscal Year '62 budget.

The *Rover* boss declared also that he wants to be in position to capitalize on any unexpected breakthroughs. This was also apparently a veiled appeal for liberal '62 funding.

• **Hopes exceeded**—Finger asserted the first three tests of the Kiwi-A experimental reactors, which ended last month, were so successful that it is now possible to make concrete plans that otherwise would have been impossible. A new series of reactor tests, the Kiwi-B series, will begin next year. "We expected a great many new problems to turn up in these tests," he said. "They didn't do so. Apparently, we were worrying needlessly."

Performance figures for the *Rover* rocket still are classified. However, it was indicated last winter that a stage weighing 40,000 lbs., generating 52,000 lbs. thrust might be built around the first *Rover*. More recently, Wernher von Braun spoke of a nuclear rocket of 80,000 lbs. thrust, possibly referring to the first-generation *Rover*.

Rover's most probable mission will be as a third stage of an advanced *Saturn* vehicle based on the 1½-million-lb.-thrust booster and the 800,000-lb.-thrust S-2 stage, which will cluster four Rocketdyne J-2 liquid hydrogen-LO engines. Presumably this first *Satur* nuclear vehicle is to become availab in the 1966-68 time period. It mig well be the propulsion system used f the first flight of the three-man *Apoll* space ship around the moon.

• **After Rover**—For manned lan ings on the moon, however, a sing *Saturn* booster is too small. NASA asking industry to study various phase of the question of which approac should be taken—the all-chemic *Nova*, orbital assembly and rendezvo with multiple *Saturn* launchings, or chemical-nuclear vehicle with a nucle second stage, much larger than *Rove*

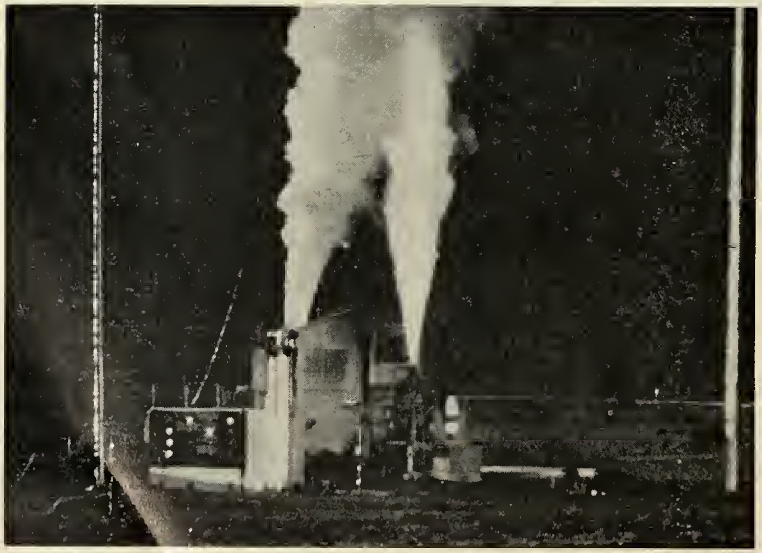
Finger envisions a post-*Rover* rock with a reactor of 10,000 to 15,00 megawatts power, which would indicat a thrust level of 500,000 to 750,000 lb This would require a chemical booste with 2½ million to 4½ million lb thrust. In the past, Finger has indicate preference for a sort of super-*Satur* liquid booster with a single F-1 1½ million-lb.-thrust engine surrounded b a circle of H-1 *Saturn* engines.

However, the NASA Office o Launch Vehicle Programs, headed b Maj. Gen. Don R. Ostrander, USAF recently has been devoting considerabl attention to very large solid booster Last month, one of a series of soli booster study contracts was assigned t look into the problems involved i building a booster weighing 1 millio lbs., with thrust of 2 to 3 times booste weight.

Even more recently, Ostrander sai in a speech that it should be possibl now to develop a solid rocket wit 500,000 lbs. thrust if desired and cluste that rocket to produce higher levels.

Finger said a nuclear stage migh be put on a solid booster as well as liquid one. He voiced concern, however, about the high thrust-weight rati of solids, which might put too muc acceleration strain on the delicate components of a nuclear upper stage.

The nuclear upper-stage vehicle will be fired from Cape Canaveral under present plans. Although studie are in progress to verify this point, Finger declared he is certain that the test would not be a hazard to populated areas on either side of the downrange areas. He estimated that construction of a new range might cost 500 million dollars.



SUCCESS OF KIWI A3 in Nevada Oct. 19 exceeded expectations, as did two earlier tests in series, giving new impetus to drive for nuclear space power.

Countdown for Survival

New President Pledged To Expand Defense Effort

AS THE PRESIDENTIAL CAMAIGN went down to the wire last ek and both candidates took differg but definite stands on the defense d space issue, one thing became ineasingly clear:

Both candidates were committed put increased emphasis and funds o the interlocking programs which ll strengthen the nation's defense d accelerate space exploration.

Both candidates, in replies to the en letter sent them by MISSILES AND CKETS, pledged themselves to speed *Polaris* and *Minuteman* programs. r. Nixon included the B-70 project; r. Kennedy did not but is known favor it. Kennedy promised a reest for a supplemental appropriain in January; Nixon said he would the same if it "would usefully serve our missile program." Both were for swift accomplishment of space exploration goals.

Both candidates recognized that the U.S. is in a strategic space race with Russia and that the military must be given the mission of ensuring freedom of space—Nixon for the first time and in deviation from the present Administration's party line.

The other most significant happening in the defense/space area last week was the disclosure by the United States Information Agency that U.S. prestige has slipped badly throughout the world since *Sputnik* and that much of this is due to our lag in the space exploration race.

- **Johnson joins debate**—Senator Lyndon B. Johnson, Democratic vice presidential candidate, issued a "White Paper" pointing out—as M/R noted last week—that the present administration has gone out of its way to deny that we are in a space race and that our prestige has fallen throughout the world. The quotes, after *Sputnik I*, included:

President Eisenhower, ("does not raise my apprehensions"); DOD Secretary Charles E. Wilson ("nice scientific trick"); Sherman Adams ("we are not interested in a high score in an outer space basketball game"); Special Advisor Clarence Randall ("silly bauble"); and Jim Hagerty, ("no race").

- **Allen or prestige**—One of the fallouts from the discussions by the candidates and their followers was the prestige issue—the matter of where the United States stands *vis-à-vis* the Soviet Union in the eyes of the world. This oblique angle of defense and space caused Sen. Johnson to include in his white paper some earlier testimony of George V. Allen, director of USIA, which took the polls. Allen testified before Congress:

"The achievement of placing in orbit the first earth satellite, without great advance fanfare, increases the prestige of the Soviet Union tremendously and produces a corresponding loss of U.S. prestige, due primarily to the contrast. The Soviets were greatly exceeding world expectation in their scientific and technological capacities; we, on the other hand, were falling short of world expectation of us.

"Then came the two dramatic and successful moon shots, followed by the failure of our own. As a consequence of these events, the seesaw seems to have tipped solidly in the Soviet direction, in world opinion. Today, although we continue to see the hope expressed abroad that the United States will catch up, we also see growing doubt that this is likely during the next 5 or even 10 years.

"Probably the most significant result of the Soviet successes is a change in the overall impression of the people of the world about the Soviet Union. In public opinion parlance, we speak of this as the revised Soviet image. The change goes beyond the field of space technology. It covers all of Soviet science and technology, plus Soviet military power and general standing.

"Before *Sputnik I*, few people of the free world believed the Soviet Union was currently in a position to challenge America in the broad fields of science, technology and production. Now, the *Sputniks* and *Luniks* are taken as evidence that the Soviet Union is able to challenge America successfully in all these fields, including even production . . ." ⁑

NASA Funds to Soar, Regardless

A BIG JUMP in the NASA budget for Fiscal Year 1962 is indicated, no matter who wins the presidential election. The rise may be as much as 40 to 50% over the current level of $915 million.

The reason for the jump is a series of programs scheduled to go from study into R&D including:

Project *Apollo*, the three-man space ship, which will cost $250 million to develop over a three-year period. Probable FY '62 funding: $50-75 million.

Saturn S-II stage, a cluster of four Rocketdyne J-2, liquid hydrogen-LOX engines with total thrust of 800,000 lbs., which will cost $100 to $150 million over three years. Likely '62 funding: $35-50 million.

Rover nuclear engine, which may go into R&D before the current fiscal year ends. However, the first big appropriation will be in '62. Probably another $50 million.

Project *Prospector*, the soft-landed, remote-control, roving moon-exploring payload, which will probably cost $300 million by 1965. Likely '62 funding: $10-20 million.

Project *Mariner*, the 600-1200-lb. unmanned spacecraft for early interplanetary missions. Probable '62 funding: $10-20 million.

Besides these programs, there are a number of expensive projects making the rounds in NASA, which might come to life if the President-elect indicates he is receptive. These include:

–*Rover* vehicle development, carried out parallel to engine development. This is a question of timing. Ordinarily, a vehicle development does not begin until the engine development is well under way. If the vehicle were developed parallel to the engine, it would make the nuclear rocket a crash program, which would cost considerably more than a more leisurely pace.

–A large-scale solid booster rocket. Another development program that ordinarily would await completion of preliminary studies, but which—if speeded—might gain valuable time in the lunar race.

–A third *Saturn* launch complex at Cape Canaveral. This expensive facility might make it possible to launch big orbital payloads on a drumfire basis. ⁑

Comment Is Both Intense and Diverse

THE LETTERS COMMENTING on M/R's open letter to the candidates, our nine-point proposal for survival and the replies from Mr. Kennedy and Mr. Nixon, continue to arrive. Many of them have been carried and others are in this issue.

Most of the comments were sympathetic with the significance of the nine-point proposal and its intent of providing a "working paper" by which the country could bring its defense and space program up to at least parity with the Russians.

Almost every writer agreed that we are lagging and that we must do more—although there were many different opinions as to the means.

Many also agreed that M/R had omitted two important projects from the nine-point program: one, the anti-missile missile and two, civil defense.

Senator Says We're Ahead

The nine points which you have submitted to Vice President Nixon and to Senator Kennedy are deserving of very serious consideration.

1. In regard to this question, the answer is yes, but we are doing a thoroughly competent job in keeping pace and in going ahead.

2. I feel that in regard to the timing you have suggested we will very well fill the bill.

3. There is no question but what the use of "space" must be in the pursuit of peace and that peace can only be insured through strength.

4. Yes, of course, we must always have outstanding defense potential.

5. I feel that the President's program as outlined in his various budget messages and as carried out in his activities bear all of the aims stated. He has shown complete understanding of the need for *Polaris* submarines and B-70 bombers.

6. The President has never felt inhibited by any budget ceiling when the security of this country has been at stake.

7. The National industrial effort is well keyed to the defense need. I am sure that the President in his overall capacity of Administration is not only fully aware of the situation, but utilizes the best instruments to bring about a successful outcome.

8. There is no question but what we will carry out all essential scientific objectives on the National level. We will not be panicked into crash programs which will have no long-range effect and which will weaken our domestic security. In my ranking position on the Aeronautical and Space Committee of the United States Senate, I am sure that we are doing everything within our power to achieve preeminence in the space race. I do not in any sense feel that this country has fallen behind. I feel complete assurance that we are ahead in the exploration of space and I will do my best to see to it that we maintain that position.

9. I think that we do have decision-making capability in the defense and space organization establishments of this country. I am not sure I quite understand the question, but I am sure that we have the decision-making capability for making decisions of the moment without reference to any long-winded debating society.

Styles Bridges
United States Senate
Washington

M/R's Proposal

1. Recognize as national policy that we are in a strategic space race with Russia.
2. Establish pre-eminent strategic, tactical and defensive forces with representation from all goals;
   - Manned space platform—1965
   - A U.S. citizen on the moon—1967-68
   - Nuclear power for space exploration—1968-69
   - A spacecraft which can take off from earth, travel to and in space, return and land under its own power—1968-69.
3. Recognize that "space for peaceful purposes" is possible only if "freedom of space" is ensured; hence that the U.S. military must be given a predominant role in developing and carrying out the projects necessary to guarantee freedom of space.
4. Establish pre-eminent strategic, tactical and defensive forces with representation from all services.
5. Recognize the necessity of greater defense funding to accomplish this, including a supplemental budget in January, 1961, to make it possible to:
   - Speed up to a maximum degree the construction of ICBM launching bases, Polaris submarines and the Mach 3 missile-Carrying B-70.
   - Provide the Army with funds to begin the immediate procurement of already-developed modern missiles, other weapons and airlift.
6. Establish further-on defense spending by need and not by budget ceiling.
7. Streamline defense regulations and procedures to make industry's role in the U.S. defense and space effort more effective.
8. Take what steps may be necessary to establish and promote national scientific objectives.
9. Re-establish decision-making in the U.S. defense and space organization.

Don't 'Splinter' Effort

You are to be congratulated for as ing for firm stands by the presidential ca didates on the vital questions of defer and space. I have read with intere Senator Kennedy's response *(Editor's No. this letter was written before Mr. Nixoı reply.)* and I should like to make sor comments.

1. On question 1, with regard to t space race, it is gratifying that the Senat has admitted that this race is real. T pronouncements of the present admin tration on this have been somewhat le than inspiring. In fact, some comments l Mr. Eisenhower have been absolute impervious to this vital question.

2. With regard to dates you sugge for various achievements, I would agr with Mr. Kennedy that they are elasti but the quality lacking in our prese planning is a sense of real urgenc or solid goals for these space achiev ments. I might note that the establishme of any date presupposes lead time, an this is rapidly slipping away as regar your goals. The dates suggested by you a at least five years sooner than any NAS planning and, thus, only a sharp revers in their thinking or the assignment space missions to the military could ha our conservative approach.

3. This question on "peaceful uses c space" is a truism, but I would point o that space, military posture and peacef uses are irrevocably tied together in th present world complex. Any attempt t isolate them is artificial, even naive. Th technology of space flight has evolve from that of missiles. The technologica problems to be bridged in scientific spac exploration are the same as those for th establishment of a military posture i space.

4. On this question, as related to organization, I can only add that until ou space effort is organized under one head preferably with a military mission, I d not feel that we will accelerate ou progress.

5-6. These questions which relate t funding have been overworked as a topic of discussion. I can only repeat comments I have made before that those who say we must limit defense and space spending because we can't afford it are doing a severe disservice to us all. A nation which spends $7 billion on liquor in one year can surely afford to add half that to plug its defense gaps, especially if that amount is less than one percent of its gross national product.

7. Streamlining is a noble effort, but

(Continued on page 44)

Congress Slaps Big 'Waste' In DOD, Major Probe Brews

CONGRESSIONAL COMMITTEES are preparing for intensive investigations of alleged waste totaling billions of dollars over the past decade in Defense Department supply management funds.

Sen. Paul H. Douglas (D-Ill.) and Rep. Thomas B. Curtis (R-Mo.), in a bipartisan statement last week, estimated that billions can be saved if DOD acts to consolidate common military supply activities, standardize purchases and use competitive bidding more widely.

The statement accompanied a report of the joint economic committee which, earlier this year, studied the economic aspects of military procurement and supply. The committee urged merging of common supply activities into a single agency at the defense secretary's level, under authority contained in the 1958 McCormack-Curtis amendment of the DOD Reorganization Act.

In another development, the Air Force warned defense manufacturers it may begin denying incentive contracts to those who continue to acquire extra profits through overstated prices rather than by improved management.

Lt. Gen. M. E. Bradley Jr., deputy chief of staff (materiel), in an address to the Aerospace Industries Assn. in San Francisco, issued the decree, apparently the strongest yet in the AF's cost-cutting and contract-improvement campaign. "We mean to insist even more vigorously that incentives are earned on the basis of improved management and engineering," he declared. "If affected companies don't take the necessary corrective action, we will simply have to stop giving them incentive contracts."

Col. A. J. Dreisezum, chief, contract administration branch, delivered the speech for Gen. Bradley.

The congressional committee recommended:

–Intensified efforts to use full competitive bid procedures.

–Aid by the Bureau of the Budget in establishing a consolidated procurement agency.

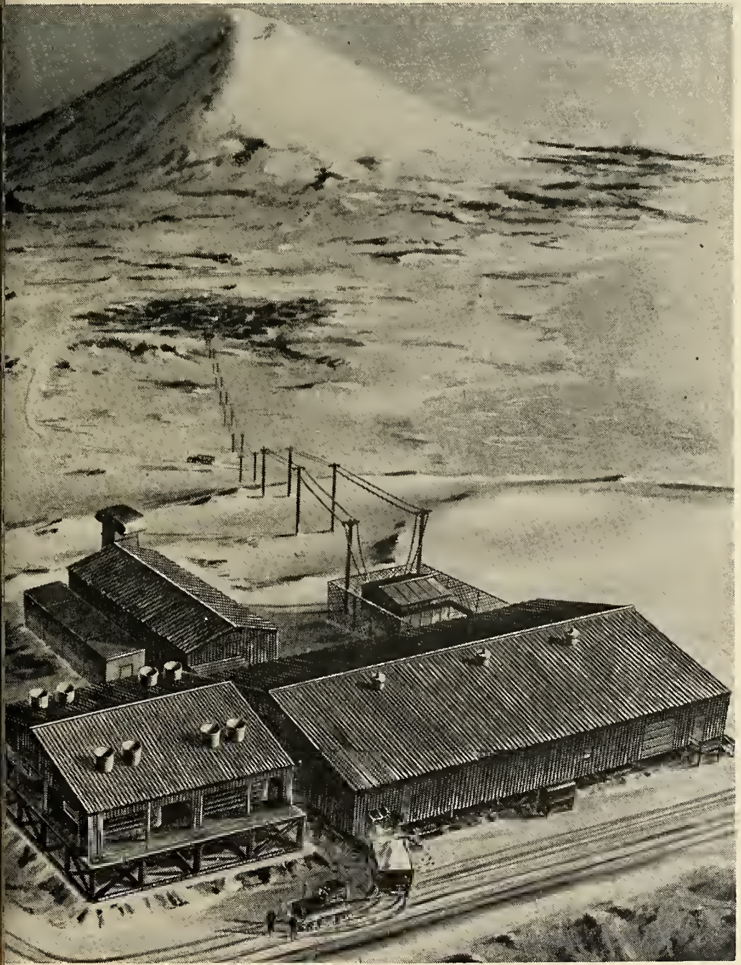
–Clarification of the role of the General Services Administration in defense procurement over the next five years.

–Granting of authority to the Commerce Department over surplus property disposal that may have an adverse effect on the economy.

–Consultation with the Commerce and Labor Departments and the Small Business Administration on procurement so as to create a more equitable distribution of the military dollar.

–Budget Bureau, DOD and GAO decision on the proper use of funds for inventory stocking and rescinding of those not justified.

–Uniform patent legislation. ⁂



First A-Power Plant for Antarctica

ARTIST'S DRAWING of atomic power plant to be fabricated by the Martin Co. in sizes of 30-ft. modules. Reactor system will be assembled by Navy Seabees within 60 days after arrival at McMurdo Sound. It will go critical 15 days later.

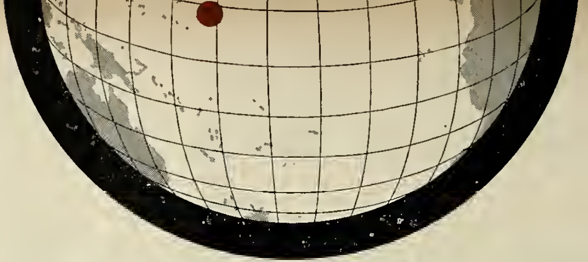
A-Test Ban Seen Keeping U.S. from Better Weapon

The nuclear test ban is holding up U.S. development of a radically new, third-generation nuclear weapon, former Atomic Energy Commissioner Thomas E. Murray charged last week.

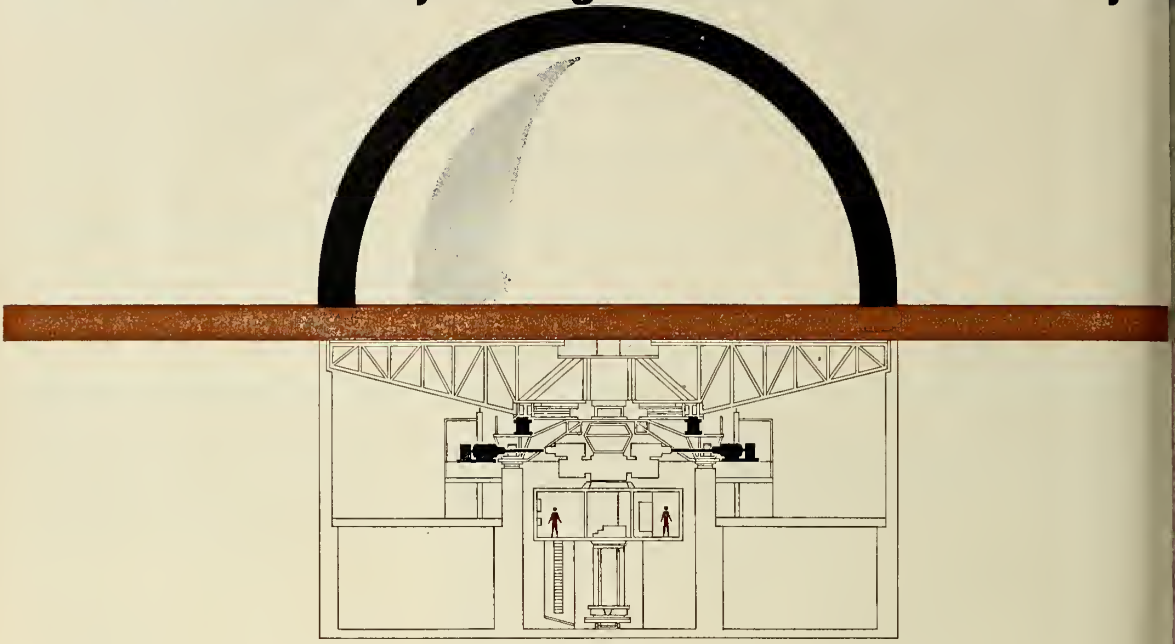
In a letter to the two presidential candidates, Murray said the new weapon is neither a "larger and more efficient H-bomb, nor a smaller and more efficient A-bomb," but will be in a different category.

"All that may be said of it here is that it is primarily anti-personnel in destination and effect," Murray declared. "Hence it is apt for properly military uses . . . It need not create suicidal hazards for the country that employs it. Therefore, a moral argument for the use of the new weapon is possible, as it is generally not possible in the case of the immense weapons of mass destruction. Further information of a classified kind is available to you from the appropriate governmental agencies."

The Atomic Energy Commission declined comment. Murray is now a consultant to the Joint Congressional Committee on Atomic Energy.



Radar Antenna Drive by Westinghouse for Nike-Zeus* on Kwajale



On some undisclosed date in the future, the free world's only anti-ICBM missile system now in development—the U. S. Army's Nike-Zeus—will face another critical test.

A Nike-Zeus complex located on tiny Kwajalein Atoll in the Pacific must detect, track and kill oncoming ICBM's. USAF crews will fire the would-be enemy (Atlas) missiles from Vandenberg AFB.

One of the key performers in the spectacular intercept will be 1250 tons of Acquisition Radar standing several stories high. Westinghouse is supplying the antenna drive motors and controls and a 30′ dia. hydrodynamic thrust bearing under subcontract to Goodyear Aircraft Corp. Westinghouse is one of the few companies, anywhere, that could manufacture a bearing of this size.

Imagine the demand for precision accuracy and delicate maneuvering to get the jump on an ICBM. Tolerances for the bearing were extremely exacting: sectors of the 30′ diameter segmented bearing must be held flat within .0005″.

Westinghouse can supply complete drive systems and mechanical components for just about any type of radar antenna. From a simple AC drive for continuous scanning on up to complex solar exploration radar. We provide the complete package: motors, gearing, controls, thrust bearings, etc.

So relay your requirements to Westinghouse . . . via the local Westinghouse sales engineer or by writing direct: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse. J-92508

*Prime Contractor: Western Electric Co./Bell Telephone Laboratories.

Westinghouse

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Technical Countdown

ELECTRONICS

esearch Aimed at Hi-Power Radars

Look for more money to be spent in R&D for high-ower radar tubes. Manufacturers are talking about oututs in the 50-megawatt range—even though many probems remain to be solved. Chief controversy centers around rossed-field versus linear-beam tubes. More mundane probems concern cooling, "window" materials, and handling igh voltages. Many questions can't be answered with equaons; experimental tubes will have to be built.

Better Solar Cells Made Available

Efficiencies of solar cells are being steadily bettered. roduction units of 12-14% efficiency are beginning to ppear on a commercial basis. One manufacturer hints at a gure of 15% for selected units off his production line.

Wrong Emphasis on Thermionic Research

More research effort should be directed at the basics of thermionic conversion of heat to electricity, says Dr. Wayne Nottingham. Speaking at a recent IRE symposium, he MIT scientist said that more should be known about hese basics before money is spent on device development.

GROUND SUPPORT EQUIPMENT

Bigger Antenna for Goldstone

A study contract for a 250-foot antenna is expected to be let within the next two months by Jet Propulsion Laboratory. The big dish will be used to augment the Lab's pace-exploration facilities at Goldstone.

Seaborne Launch Pad Pushed

Navy is pushing its plans for a seaborne launching, racking, and recovery ship. Vice Adm. W. F. Raborn, Jr., pecial projects chief, implied that such a vessel could be operational next year if authorization is given soon. Adantages claimed for the astronautics ship: privacy of opertions, and money saved by mobility—which would make t possible to meet different launch site location reuirements.

More on Solar-Storm Forecasting

"Weather forecasts" of solar activity may be possible in he future. But Dr. Joseph Friedman of NRL says they ren't feasible at the present stage of knowledge. Apparntly, the *Apollo* astronauts will have to depend on shieldng to protect them from blasts of solar energy.

CA Begins Operation of "White Alice"

RCA Service Co. last week took over full operation of he Air Force "White Alice" communications network linkng the Alaska Communications System, DEW Line, and MEWS. The 33-station network uses radio (including catter propagation), cable, and long-line installations to rovide communications for civilian, military, and other overnment agencies in Alaska.

BMEWS Tracing Radars Being Installed

Installation of the first of the 84-ft. radars for BMEWS has started at the Thule, Greenland, site. The huge tracking radar—enclosed in a 140-ft. plastic radome—will supplement the stationary detection systems already in operation.

PROPULSION

New Sounding Rocket Tested

Rocketdyne has successfully tested its now low-cost, high-altitude, solid, weather-sounding rocket at Fort Hood, Tex. The vehicle's reinforced plastic shipping container serves as its launching tube. It can be fired from a 5-inch gun or set up and fired from the container by one person.

250-Ton-Thrust Rocket Envisioned

The next big solid rocket developed probably will have 500,000 lbs. thrust. Maj. Gen. Don R. Ostrander, NASA chief of launch vehicle programs, says it should be possible to build a ½-million-lb. solid and cluster it for larger vehicles.

20-Megawatt Space Power Considered

NASA's 1962 budget may include funds for developing a 300-kilowatt nuclear powerplant for space vehicles. NASA also is considering power levels of 1 Mw and 20 Mw.

Another Break for Storables

Small mobile ICBM's called for under SAC's SR19782 and TAC's TMX 161 proposal may have storable-liquid engines capable of 40 to 50 thousand lbs. thrust. This would be sufficient to provide ICBM range and still deliver warheads desired by the Air Force in the 1965-75 period.

ADVANCED MATERIALS

HOH as an Oxidizer

A classified propellant delivering 360-375 sec. I_{sp} is in the works at Aerojet-General. The fuel uses water as an oxidizer and can be produced easily and economically by the chemical industry.

Second Thoughts

Rocketdyne is apparently having second thoughts on publishing a manual covering the compatibility of certain liquids with specified hardware. A type of "which-valve-works-with-what-liquid" book, it could bring some unpleasant reactions from the firms involved, if published.

ASW ENGINEERING

New ASW Office at Lockheed

Lockheed Aircraft has established a new organization to direct ASW and ocean systems research and development and to coordinate corporate efforts in these areas. Thomas P. Higgins, Jr., will be technical director of the new group.

Raytheon Reduces Radome Machining

Complex shapes posed production bottleneck; solution evolved from old 'classroom' machining problem

RADOMES FOR THE Navy's *Sparrow III* air-to-air missile are being machined at the rate of one every 28 minutes by Raytheon Co. at Lowell, Mass.

Previously, the process took more than 20 hours per item, and the mere idea of producing 300 radomes a month seemed all but impossible.

What bothered Raytheon's production engineers was the fact that because of variations in the dielectric quality of the material used, each radome had to be rough-machined and given a preliminary boresight test. From this test, the machining pattern for that particular radome was developed.

This meant that each radome was unique and had to be machined differently. Since a radome is in effect a lens through which electronic signals pass and are refracted, the microwave signals must be concentrated in one place.

To facilitate this focusing, the wall must vary in thickness but be radically controlled to a tolerance of 0.0015 in.

This variation in thickness is accomplished by machining the outside diameter to an elliptical shape. In addition, the radome has an overall artillery-shaped ogive to reduce air friction.

Henry Sokolsky, of Raytheon's Missile Systems Division, says that after a considerable effort better control of the radome materials was achieved and a master pattern for exterior machining was developed.

First, the ogive shape was rough-machined on a tracer-controlled lathe, keeping the cross-section round. Elliptical contour was achieved by center offsetting and remachining in a series of small arcs the length of the radome. Finally, the arcs were blended by hand sanding.

This process was costly, tedious and required more than 20 hours per radome on special tracer lathes. Since the material of construction is laminated glass fiber cloth, carbide tools had to be used. And, to keep the radome from tearing, it was necessary to revolve it as least 90 rpm.

• **No outside help**—All types of tracer controls were unsuitable. The trouble was that, in turning an ellipse the turning tool had to make two cycles in and out, for each revolution of the radome. No available tracer could hold the required tolerances at 180 cycles per minute.

Leading machine tool manufacturers were consulted, but the ideas they provided did not prove out.

Raytheon tackled the problem first by taking the speed out of the work and putting it into the tool itself. A grinding wheel of the proper grade was tried and found to be far more satisfactory than turning.

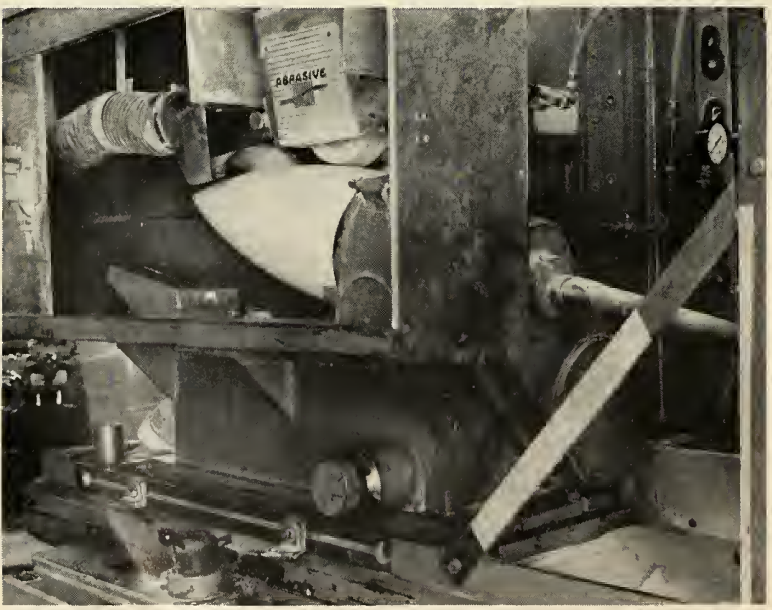
Then Sokolsky recalled a problem thrown at him in his younger school days. He had been asked to machine a rectangular block on all its surfaces using only an engine lathe.

This he did longitudinally by locking the tool in the chuck and placing the work on the carriage. He then ground the work longitudinally, indexing after each stroke. When the sides were made small enough and the cuts were overlapped, a round configuration developed. Why not apply this to radomes?

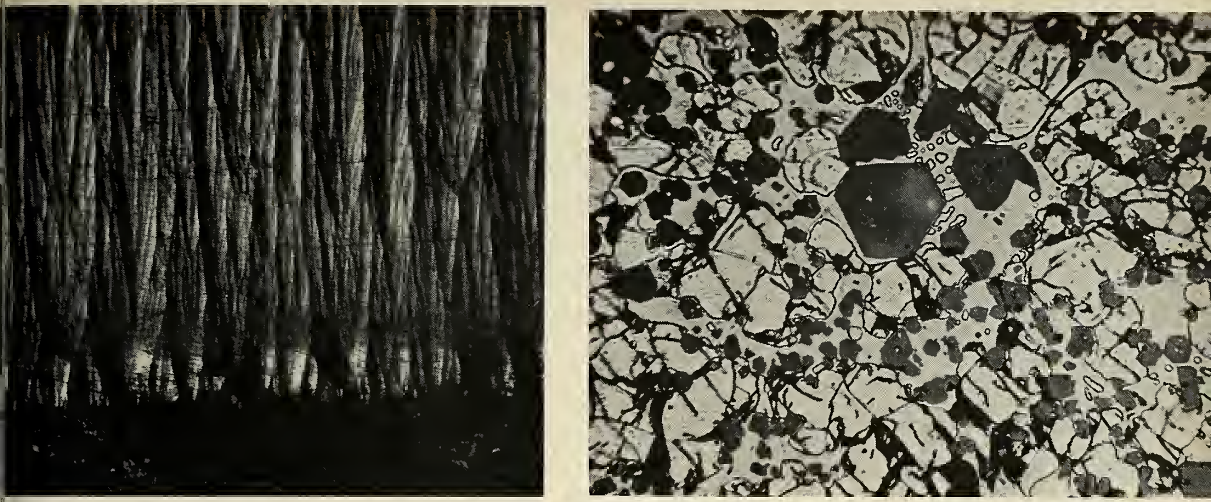
Consultation with the Abrasive Grinding Co. led to the development of a horizontal grinder with a rise-and-fall head which would carry both the grinding wheel and a roll follower. The movement of the head is controlled by the roller traveling back and forth over a master radome.

The master radome drives, and revolves on a 1-to-1 ratio, the unfinished radome under the grinding wheel and automatically indexes at the end of each stroke.

With this machine, the entire operation takes only 28 minutes and produces a better finish than the hand method. ⌘



HORIZONTAL GRINDER with rise-and-fall head finishes the artillery-shaped ogive on a radome while imparting a close-tolerance elliptical cross-section.



REFERENTIAL ORIENTATION in AMP anisotropic graph- is illustrated on the left. Profound performance improvements result from a thin layer of this on high-density graphite. Right: nozzle section of TiC-SiC coated graphite (500X).

High Temperatures Spur Novel Graphite Developments

arbon and carbon complexes seen filling materials oid created by solid-propellant rocketry advances

by John Judge

THE "BOOM" in solid rocket tech- logy is causing a tremendous surge high-temperature materials develop- ent.

One of the fresh young leaders in e field is the Engineering Science ivision of American Metal Products ompany, Ann Arbor, Mich.

In the past two years, the Division s created, developed and placed in oduction novel processes for prepar- g high-temperature materials suitable r solid-propellant rocket engines.

A major area of interest—one that tablished AMP in the rocket field—is sign and production of structures in- lving carbon and carbon complexes.

Much research in carbon chemistry aimed at meeting the challenges and chnical advances of high-performance opellants. For this effort, AMP has en providing graphite shapes with ntrolled diffusions of a number of etal carbides.

Silicon, titanium, zirconium, tungs- n, tantalum, hafnium and niobium rbides are under investigation. In dition, mixed binary and ternary rbide systems are involved in the pro- am. AMP says long-range high- nperature applications demand better owledge of these systems.

Graphite itself has received consid- able attention at the Engineering Sci- ce Division and various forms and combinations of this material have evolved.

Proprietary processes employed at the Division and have produced a super-density, isotropic, high-strength graphite.

Designated AHDG (American High Density Graphite), the material has a uniform structure with uniform pore volumes. It is gas-free at temperatures up to 5500°F, and has excellent thermal shock resistance. Densities range above 1.90.

Precision-dimensioned shapes and forms take the general geometries required for aft closure inserts, blast tube inserts, entrance cones, nozzle inserts, and exit cones.

In general, its mechanical and thermal properties improve with temperature up to the currently available flame temperatures of solid propellants.

Test firings indicate that the erosion rate of this graphite is around 40% that of conventional graphites.

- **Pyrolitic plumbago**—On the other end of the graphite spectrum, ESD scientists have developed an anisotropic polychrystalline material with preferential orientation in one plane. Commonly known as pyrolytic graphite, this material is characterized by being a thermal insulator in a direction normal to the surface of deposition, while being a thermal conductor in a direction parallel to the surface.

Although the AMP anisotropic product (designated AIC) generally exhibits a 100-to-1000-fold difference in thermal conductivities between the (ab) and (c) planes, certain samples have tested as high as 2000.

Test firings of AIC pyrolytic graphite backed up by AHDG graphite indicate that the erosion rate of the composite material is about 1/10 that of untreated high-density graphite and about 1/25 that of conventional graphite.

Also, AIC pyrolytic graphite in massive "free standing" form is being used in nozzles, nose cones, specialized types of heat sinks and blast tubes.

- **"Case hardened" graphite**—Another development of the Engineering Science Division is "heat-treated" graphite. This material is composed of a base of AHDG isotropic graphite with an upgraded surface of recrystallized graphite. The combination has demonstrated superior qualities in over 400 rocket engine firings.

In the rocket exhaust environment, the heat-treated surface shows excellent erosion resistance, improved oxidation resistance, and very desirable mechanical properties. Heat-treated nozzles have actually survived 10 to 15 repeated firings. The AMP process for heat-treating graphite is somewhat similar in effect to the case hardening of metals.

Developments move extremely fast. In one instance, AMP sent an experimental nozzle for firing tests. Since these specimens must wait their turn, it takes about two weeks for the nozzle to be completely tested. During this time AMP came up with an improvement that all but rendered the original nozzle obsolete, and a substitution had to be made. The second nozzle proved its superiority. ⁂

RF Plasma Torch Developed

A CHEAP, simple plasma torch reaching temperatures up to 20,000°K and generated with only 3 kw of power, has resulted from studies conducted by Dr. T. B. Reed at the Lincoln Laboratory of Massachusetts Institute of Technology.

The torch is based on inductive coupling to an ionized gas at or near thermal equilibrium. Thus the high temperatures can be achieved by using a moderate-sized power supply of the type usually associated with RF heating.

The high temperature region is of appreciable extent, not at a point focus, and therefore completely accessible for introduction or manipulation of materials to be heated.

• **Clean heat**—The main feature of the torch is that there are no contaminating combustion products and operates with any desired single gas or mixture.

According to Reed, the induction plasma torch is a quartz tube, open at one end with gas supplied at the other. An RF coil of a few turns surrounds the tube at its center and serves as the power supply.

Reed has observed that the plasma is equally stable and more easily visible when a flat, five-turn pancake coil is employed.

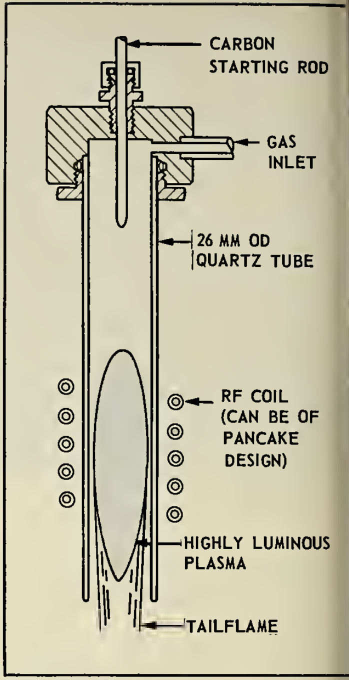
Starting is accomplished by creating a "pilot" plasma within the RF field. This lowers the breakdown potential of the gases sufficiently for the plasma to be established in the high RF field present before starting.

The coupling is initiated by heating a graphite rod or refractory wire loop inductively within the RF field, and then withdrawing it. The main plasma field then becomes the heat source for incoming gases. Tubes direct and control the gas flow in the vicinity of the electromagnetic field. The gas is ionized and a jet of high-temperature plasma projects from the open end of the tube, resembling a torch.

Temperatures approaching 100,000° without excessive power requirements appear feasible if some method can be developed to contain the plasma.

The induction plasma torch is ideally suited to crystal production by the Verneuil method because of its freedom from combustion contamination.

Lincoln Laboratory is operated by MIT with the joint support of the Army, Navy and Air Force. ⁘



PLASMA INDUCTION torch reach about 10,000°K at the edge of the plasm region. While at the heart of the regio temperatures reach up to 20,000°K.

PROJECT-READY

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Small propulsion systems available *now* from Propellex inventory . . . ranging in total impulse from 1 lb.-sec. to 1000 lb.-Secs. with thrusts up to 4000 pounds.

ROCKETS: Propellex has designed and developed a wide range of rockets that can be used "as is" or easily modified to meet your specifications. Among these are retro, separation, spin and ground support rockets.

PYROGENS: Somewhat new to the industry are igniters for rockets and gas generators characterized by controlled production of ignition gases. These, too, are *shelf items* from Propellex — immediately available for your next project.

Rely on Propellex rockets and pyrogens to cut down on your own r & d . . . help you finish important projects in a minimum of time.

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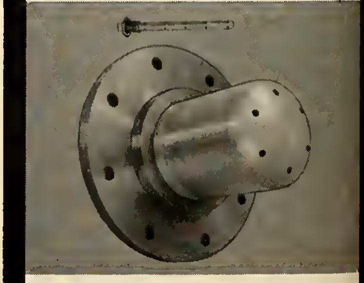
MODEL 99 ROCKET. Designed by Propellex for McDonnell Aircraft feasibility study on small weapons systems propulsion units. Readily modified for other applications.



MODEL 90 PYROGEN. Designed and developed by Propellex for United Technology Corporation. Low in cost due to simple design. Easily modified to produce different mass flow rates as required.

Circle No. 10 on Subscriber Service Card.

PATC Tailored to Space Rendezvous

Two-year development by Marquardt is being used for one satellite program; has been run 4 minutes

THE MARQUARDT CORP. has veloped a propulsion system specially signed for rendezvous in space and her requirements of extremely pre- se orbital correction.

The system recently was chosen for ie military satellite project. Mar- iardt's Controls & Accessories Divi- on says it has wide application for her space missions.

Hypergolic storable liquid propel- nts are used. Most of the Marquardt ork has been done with nitrogen troxide with hydrazine and mixtures hydrazine and related fuels, depend- g on freezing-point requirements.

Total impulse is controlled on a gital basis by using a series of pulses, tained by injecting small amounts of opellant into the chamber at a time. ilses are produced at a rate estab- hed by the guidance error input gnal.

Marquardt engineers contend that act orbital correction is easier and eaper to obtain in the satellite itself an with large, expensive thrust cor- ction systems in the booster and wer stages.

The system, called Position, Atti- de and Trajectory Control (PATC), n, as its name implies, also be used to ovide small amounts of impulse for ljustment of orientation and station.

• **How it was developed**—Mar- iardt began work on the concept two ears ago with a converted diesel en- ne operating on UDMH and RFNA. small, 2 hp reciprocating power unit as built, designed to run at 6000 rpm ith propellant injection over 30 to 40 crankshaft rotation. Thus the injec- rs opened, injected fuel and closed in to 2 milliseconds. With the equip- ent, Marquardt demonstrated feasi- lity and performance capabilities of a ilse rocket with pulse widths of 3 to) ms and with a repetition rate vary- g from single pulse to 100 cycles per cond.

Later, a vehicle attitude control sys- m was developed with the use of $_2O_4$ and hydrazine. Propellants are d by nitrogen pressure. The total iantity of propellant injected during single pulse depends on the dwell time of injectors in the position that establishes pulse width. This minimizes mechanical delays and those caused by the travel of fluid through supply lines.

The rocket chamber and nozzle are, for most requirements, uncooled structures. Radiation cooling will maintain temperature levels in long-duration operation at low duty cycles—such as 25% on and 75% off. For short duration at a high duty cycle, heat sink will be adequate.

For engines of 500 and 1000 lbs. thrust, Marquardt is experimenting with two kinds of nozzle—one of tantalum and one with a graphite throat inserted into an ablating inner surface.

Individual pulses can be as small as .001 lb.-sec., which makes the propulsion system adaptable to digital as well as analog error signals.

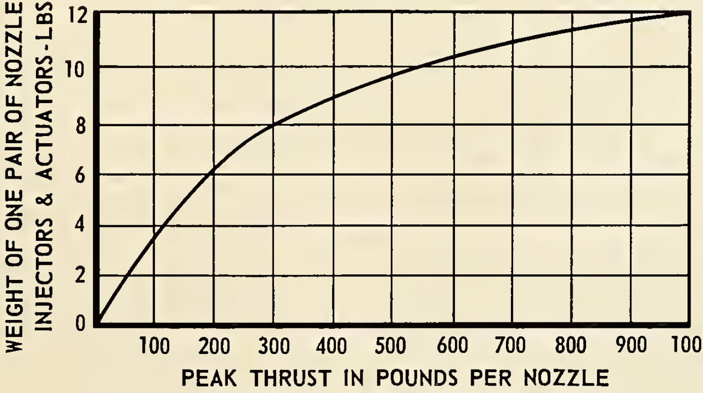
The system has been run up to four minutes duration, restarting 200 times a second. Marquardt said details of the injector used at that rate are proprietary. ⌘

Formula for Versatile PATC

1. Weight of one pair of Nozzles, Injectors and Actuators = ——— (Obtain from curve below)
2. Dry Weight of Additional System Components (Tanks, Pressurization valves, etc.) less Nozzle Assemblies and Plumbing = $\frac{I_{Total}}{1500}$ = ———
3. Weight of Plumbing (Dependent upon Installation, Use 10 to 30% of Item 2) = ———
4 Weight of Propellant = $\frac{I_{Total}}{I_{sp}}$ = ———
5. Estimated Volume (Cu. Ft.) = $\frac{I_{Total}}{17,000}$ = ———
6. Electrical Requirements:
   a. 10 watts per pair of nozzles or 775 watt seconds per lb. of propellant for pulsing power
   b. Approximately 3 lbs per pair of nozzles for electrical conversion package (Converts senser signal to desired input to injector actuators.)

TOTAL EST. WEIGHT = ———

$$N_2H_4 \text{ Weight} = \frac{\text{Total Propellant Weight}}{2.34}$$



Position, Attitude and Trajectory Control Systems

Estimate of Weight, Volume and Power Requirement

(Hypergolic Fuel Combination of N_2H_4 and N_2O_4)

NASA Prods Electric Propulsion Work

Spectacular weight advantage of ion and other units speeds plans; ion, plasma devices to be flight-tested early in 1963

by Jay Holmes

ION AND OTHER electrical propulsion, which could increase interplanetary payloads by a factor of three or four, are getting increased attention from the National Aeronautics and Space Administration.

To fulfill the elaborate plans outlined last week by NASA's Jet Propulsion Laboratory (M/R, Oct. 31, p. 15), propulsion specialists are speeding plans to develop small devices capable of reducing greatly the cost, weight and complexity of launch vehicles required for missions to Mars, Venus and beyond.

A target date of 1965 has been set for the first orbital flight of the two electrical systems that are nearest to being operational—ion and plasma units. The two may be aboard the same satellite, powered by a single 60-kilowatt SNAP-8 nuclear reactor.

Hughes Aircraft Co. is now building a laboratory model of the first ion propulsion unit, with thrust of 0.01 lb. In Fiscal Year '62, NASA hopes to award a contract for development of a flight version ion device, with total thrust of 0.1 lbs. If the Hughes approach should be chosen, the smaller unit could be scaled up, or a cluster of 10 might be used.

- **Test plans**—First flight tests are programed for early 1963. First flights will not be orbital, since the first requirement of the development program will be to demonstrate that an ion engine acts as theory predicts it will in the near-perfect vacuum of outer space. It is impossible to make the demonstration anywhere on earth for two reasons. First, it is impractical to pump a hard enough vacuum in a sufficiently large chamber. Second, any chamber will have walls that will reflect ions and electrons back into the thrust stream.

The flight tests beginning in 1963 will be a series of four sounding rocket launches. Since power will be needed only for a fairly short time, it will be provided by banks of batteries instead of the SNAP-8 nuclear reactor.

NASA officials are now studying which rocket to use for the tests. Two under consideration are *Scout* and *Argo D8*. *Scout* is attractive because, when used as a sounding rocket, it provides an hour of operating time under vacuum conditions. However, the payload would be enormously heavy. Batteries to provide 30 kw for an hour probably would weigh about 1000 lbs.

A possible compromise might be a three-stage *Scout*, which is capable of lifting 1300 lbs. to 1000 miles.

- **Completing studies**—The plasma unit will not need flight testing before the 1965 orbital shot, since it can be checked out completely on the ground. General Electric and Avco are engaged in one-year competing studies of different technical approaches for a unit of ½ lb. thrust. When the studies are completed next summer, NASA expects to choose one of the two and go into R&D.

The difference between the two types of propulsion is in specific impulse and thrust. Ion propulsion provides higher specific impulse, probably between 4000 and 6000 sec., while that for plasma propulsion is in the range of 1000 to 1500 sec. However, the plasma unit gives higher thrust at a given power level.

As a result, the ion engine is best suited for interplanetary missions, where specific impulse is an overriding factor. The plasma unit may be better for such a mission as lifting from a low orbit to a 24-hour orbit.

The first flight is programed for th *Atlas-Centaur* launch vehicle. Electric propulsion units will probably be use in *Saturn*-boosted missions too. However, larger engines will be necessar for optimum application to *Satur* payloads.

- **Clear advantage**—Here are som figures that indicate the advantage c ion propulsion for interplanetary missions. *Centaur* will have a capability o putting payloads of 8500 lbs. into 300-mile orbit or 1450 lbs. into a escape trajectory.

If the *Centaur* is programed for low orbit, a SNAP-8 powerplant an a pair of ion engines, weighing abou 3000 lbs., might be made part of th payload. At a specific impulse of 600 sec., about 450 lbs. of cesium propellant would be consumed in boosting th spacecraft from orbital to escape velocity, leaving a net payload of more tha 5000 lbs.

If a hydrogen-oxygen stage wer added to the vehicle, the weight of propellant alone needed to generate enoug impulse to achieve escape velocit would be 7000 lbs., leaving even les payload than with a two-stage *Centau* alone.

Actually, according to Capt. Richard J. Hayes, USAF, NASA's chief o ion propulsion, there is no theoretica reason why specific impulse need b limited to 6000 sec. It might go up t 20,000 sec. or more in the near-perfec vacuum of interplanetary space. Thi would mean that much less than 45

Electric Rockets, Performance Ranges

Thrust Device	I_{sp} (sec.)	Estimated Efficiency (%)
Arc jet (steady state, gas propellant)	1000-2000	80
MHD accelerator (steady state)	4000-8000	40
Pulsed plasma	5000-20,000	10-40
Ion	3000-100,000	75-95
Charged colloids	1000-4000	99

ɔs. of cesium would be needed for the ıission mentioned above.

However, it is impossible to prove ıe higher impulse figure without experiments in space.

- **Other interests**—NASA is intersted in several other areas of electrical ropulsion. Plasmadyne is developing a -kw arc jet to be powered by the *unflower* solar collector, which will be sed for attitude and orientation con-ol of large spacecraft.

Bids are now being evaluated, for ontract award in about a month, on ıagnetohydrodynamic engine studies. Iowever, NASA does not plan early :&D in that field because too little is nown in the field.

Studies also are expected to be let ı the current fiscal year on colloid ropulsion. However, the pressure of vork at NASA headquarters will probbly delay procurement until after the rst of the year.

The largest item in the electrical ropulsion budget is for supporting tudies. Hayes says he will be receptive ɔ proposals on negative ion work, ion ptics, ion sources and cooling techiques. Some of this work will be done ı universities.

NASA's budget for electrical proulsion rose from $1.3 million in FY 50 to $3.3 million in the current year. lthough NASA spokesmen decline to iscuss the '62 budget, it is obviously oing to jump again.

Procurement is handled both by ıeadquarters and the Marshall Space light Center, Huntsville, Ala., where)r. Ernst Stuhlinger has a staff of 10 eeping track of efforts in electrical ropulsion. Contracts totaling $100,000 r more must be approved by headıuarters, where Dr. Harry Harrison is hief of space propulsion. ⁂

Two '61 Rocket 'Intervals' Scheduled by COSPAR

Two major international rocket intervals" have been scheduled for 961 by the Committee on Space Reearch (COSPAR) of the International ouncil of Scientific Unions.

The first, Feb. 12-18, will deal rimarily with the total solar eclipse xpected Feb. 15, and with winter atnospheric structure in the Northern Iemisphere. The second interval, July 6-25, will emphasize atmospheric tructure during the Northern Hemiphere summer.

About 27 research rockets were ired as part of the U.S. contribution o the interval Sept. 16-22; twenty-two vere for meteorological measurements, he rest for other geophysical investigaions.

SNAP's Seen Top Space Power Sources by 1970

Los Angeles—Nuclear SNAP systems currently under development will be by 1970 the predominant and most reliable source of high power available for application in space satellites.

That prediction was made by Ralph Balent, Director of the Compact Power Systems Department of Atomics International, at the Aircraft Electrical Society 1960 display here.

Balent cited the recent 1000-hour uninterrupted operational test of the SNAP experimental reactor (SER) at 50 kw thermal power and 1200°F, as evidence of the "extremely stable, predictable and satisfactory operation" of SNAP units. The SER, a 220-lb. reactor containing about 6.4 lbs. of homogeneous U_{235} fuel, produced 150,000 kwh of thermal power in its 4000 hours of tests over an eight-month period.

- **Coming systems**—Balent provided some new details of the systems currently under development at AI, a division of North American Aviation, Inc. These include SNAP 10, SNAP 2 and SNAP 8, in order of increasing electrical power output.

SNAP 10, expected to be available in 1963, has a 300-watt output and a minimum life of one to three years. SNAP 2, a 3-kilowatt system, will be available about 1964, with a minimum life of one year. Greatest power output will be from SNAP 8, totalling 35,000 watts, with a capability of producing 70,000 watts through the use of two power conversion units with the same reactor. This system is expected to be in use by 1965, with a minimum life of one year.

Operation of the SNAP systems varies with the type of power conversion utilized. A turbo-machinery system will be used in the SNAP 2 and 8 programs, while thermoelectric conversion will characterize the SNAP 10 unit.

Basic reactor types will be the same for all systems. A reactor using a homogeneous fuel of U_{235} in zirconium hydride will provide energy for system operation. For generation of one megawatt/day (thermal) in the system, one gram of fissionable fuel is consumed. In SNAP 2, one-half of one percent of the total 6.4 lbs. of fuel will be consumed in one year. In SNAP 8, this figure will be 5%.

Use of zirconium hydride, Balent said, minimizes weight in the reactor, by taking advantage of its similarity to water in hydrogen content, but avoiding the necessity for a heavy pressure vessel due to 1200°F operation. Water, with a high hydrogen-atom content, is an excellent moderator. Closest to water in hydrogen content is zirconium hydride. The reactor temperature of 1200°F, however, would prevent water from being used without a thick pressure vessel. Zirconium hydride needs no such vessel, and fills the job very well.

- **Long-lived model**—SNAP 10, the reactor which will be available first, has no moving parts and requires no active control system. Startup in orbit is accomplished by moving the two halves of the reactor together until criticality is reached, the system then being allowed to seek its own equilibrium temperature. System control is provided by a strong negative temperature coefficient of reactivity, inherent in this type of reactor.

The static nature of thermoelectric conversion is the prime reason for SNAP 10's development, and the reason for its longer minimum life. In this system, 700 thermocouples of lead telluride and germanium bismuth telluride are located about the reactor reflector in a layer 1½ in. thick.

The reactor, with a core diameter of 7 in. and a length of 10 in., is surrounded by a reflector and conduction plates of beryllium, and is equipped with radiator fins.

- **Adequate efficiency**—The 700 thermocouples each generate ½ watt of electrical power. Overall efficiency of the unit is only 2½ to 3%, although the doped lead tellurides are capable of 10 to 15% of Carnot conversion efficiencies at temperatures below 1200°F.

"We could improve the efficiency of the system," Balent said, "but it's not worth the effort to gain slight efficiency improvements, when the saving in fuel is academic."

The thermocouple hot junction is maintained by contact to the reactor surface, while the cold junction is maintained by contact with the radiator fin. The radiator, rejecting heat into space, maintains the proper temperature gradient and heat flow through the conversion material.

SNAP 2 and 8 systems will employ generally similar mechanical conversion methods, although the reactors will differ. SNAP 2 will use a reactor similar in type to SNAP 10, but will have a small mercury vapor turbine-alternator Rankine power conversion system. The liquid sodium-potassium-cooled reactor will drive only one moving part, a combined rotating shaft suspended on liquid mercury bearings and rotating to 40,000 rpm. Power conversion sub-system is under development by Ramo Wooldridge. ⁂

NOVEMBER, 196

Missiles and Rockets

ASTROLOG

A status report on U.S. missiles and rockets and all space vehicles presently in orbit

★ *Indicates change since September 12 edition*

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
SPACE VEHICLES			
ADVENT (Army)	Army Signal Corps, prime, GE-Bendix prime for polar-orbiting phase	New overall name for advanced communications satellites STEER, TACKLE and 24-hour instantaneous repeater called DECREE	R&D
AEROS (NASA)	No contract announced	24-hour weather satellite to be boosted by CENTAUR or SATURN	Planning. First flights would be i 1964 or 1965
★AGENA (Air Force)	Lockheed, prime; Bell, propulsion	1700-pound satellite after burnout; AGENA B stop-start engine about double fuel capacity of AGENA A	Used in DISCOVERER program larger AGENA B also to be use with ATLAS and THOR
★APOLLO (NASA)	Convair, Martin, G.E.	Three-man spacecraft capable of orbiting moon or becoming space station; probably winged for lunar flights; boosted by SATURN	Six-month studies in progress; R&D prime to be chosen in FY '62
★ATLAS-ABLE (NASA)	STL, prime; GE/Burroughs, Arma, guidance; Rocketdyne, Aerojet-General, ABL, propulsion	Orbit 200-lb. vehicle around moon or send into deep space	Last attempt in 60 days
★BLUE SCOUT (Air Force)	Aeronutronic, prime; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol, propulsion	Solid multi-stage booster similar to SCOUT	First BLUE SCOUT launching partl successful in September
CENTAUR (NASA)	Convair, prime; Pratt & Whitney/-JPL, propulsion	Pair of LOX-liquid hydrogen engines, 30,000 lbs. total thrust, atop ATLAS booster, capable of orbiting 8500 lbs. or accelerating almost 1450 lbs. to escape velocity	First test flight in 1961; first engine delivered
★COURIER (Army)	Army Signal Corps, prime; Philco, payload; Radiation, antennas; ITT, ground stations	Delayed repeater communications satellite; 51 in. diameter, 500 lbs.	COURIER IA launching failed in August because of booster blow-up. COURIER IB placed in orbit Oct. 4, successfully transmits messages and pictures
★DISCOVERER (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA launchings of early stabilized satellites; main purpose is to test techniques for SAMOS	16 launchings; capsule recovered from orbit on No. 13 & 14. No. 15 capsule unrecovered from Pacific because of rough seas. DISCOVERER XVI failed to go into orbit because of separation failure between THOR and AGENA B. Total 35 shots
DYNA-SOAR I (Air Force)	Boeing, space craft and systems integrator; Martin, propulsion	Boost-glide orbital space craft; first space bomber; TITAN I booster; TITAN II probably to be used later	R&D; first glider flights from Edwards AFB by 1962; intensive material studies underway; R&D space flight about 1966
★ECHO (NASA)	Langley Research Center, prime	Puts 100 ft. inflatable sphere in 1000 mile orbit; passive communication satellite; next model will include internal supports	Second launching attempt successful Aug. 12; next shot next year
JUNO II (NASA)	Marshall Center/Chrysler, prime; Ford Instrument, guid.; Rocketdyne/JPL, prop.	Early deep space booster; small payload	Five more shots planned
MARINER (NASA)	JPL, prime	600-1200 lb. unmanned spacecraft for early interplanetary missions; boosted by ATLAS-AGENA B	Seven shots planned beginning next year
★MERCURY (NASA)	NASA, prime; McDonnell, capsule	First manned satellite; 1 ton capsule boosted by ATLAS	Program slipping about one year. First manned capsule launching by REDSTONE down Atlantic Range slipped to early 1961. First manned orbit shot scheduled for late 1961

MIDAS (Air Force)	Lockheed, prime	Early-warning satellite; detect ICBM launchings by infrared before birds leave pad; R&D models weigh 2 tons; operational system to have 12-15 satellites	R&D; second launching May 24 partial success
★NIMBUS (NASA)	No contracts announced	2nd generation weather satellite; THOR-AGENA B booster	First launching scheduled for early 1962, but procurement delay makes date doubtful. Letting of several subsystem contracts expected soon
NOVA (NASA)	No prime announced; Rocketdyne, propulsion	Clustered 6-9 million lb. booster plus upper stages	Early R&D on 1.5 million lb. F-1 engines
★OAO (NASA)	Grumman, prime; Westinghouse, eletronic components	3500-lb. orbiting astronomical satellite observatory equipped with telescope; boosted by ATLAS-AGENA B	First flight scheduled in late 1963
★OGO (NASA)	No contract announced	1000-lb. satellites with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; ATLAS-AGENA B booster	First flight scheduled in early 1963. Contracts expected soon
ORION (ARPA-Air Force)	General Atomic	Space station launched by series of atomic explosions	Advanced engineering studies under way; tests may be attempted; program shifted to Air Force alone
★OSO (NASA)	Ball Brothers, prime	350 lb. orbiting solar observatory; THOR-DELTA booster	First flight planned early in 1961
PROJECT 3059	Aerojet-General, Grand Central, propulsion	Solid motor in 1 million to 2 million lb. thrust class	Research determining feasibility; NASA contracting for complementary studies with United Technology Corp.
★PROSPECTOR (NASA)	No contract announced	Soft-landed, remote control, unmanned moon exploring spacecraft. SATURN booster	First flight planned by 1965; study contracts to be awarded in 1961
★RANGER (NASA)	JPL, prime; Aeronutronic, capsule; Hercules, retrorocket	300-lb. rough landed instrumented capsule on moon; ATLAS-AGENA B booster	R&D; first flight planned 1961; first lunar landing planned for 1962
REBOUND (NASA)	No contract announced	System of 12 or more passive communications satellites launched several at a time	Study
★ROVER (NASA, AEC)	No prime announced	First nuclear rocket	R&D contractor to be chosen soon
★SAINT (Air Force)	No contracts announced	Anti-satellite satellite system for both inspection and interception	Study contract awards due in November
★SAMOS (Air Force)	Lockheed, prime	Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs.	R&D; stabilization already achieved in DISCOVERER series; first launch failed to put SAMOS in orbit Oct. 11; scheduled to be operational late 1962, early 1963 under new, bigger program
★SATURN (NASA)	NASA Marshall Center, prime and booster; Douglas and Convair, upper stages; Rocketdyne, booster and midstage engines; Pratt & Whitney, topstage engines	Series of multistage vehicles based on 1.5-million-lb. clustered booster and upper stages using combinations of LOX-liquid hydrogen engines. Earliest model will orbit 20,000-lb. payload	Second series of static firings to begin in Nov.; firings of clustered booster first flight test spring of 1961; flight with live upper stages scheduled 1963
★SCOUT (NASA)	Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Hercules/Thiokol, propulsion	Solid four-stage satellite launcher; 200 lb. payload in orbit	First four-stage flight successful in Oct.; orbital shot expected in next few months
SURVEYOR (NASA)	No contract announced; STL, McDonnell, North American, Hughes competing	Soft-landed 100-300 lb. instrumented spacecraft on moon; ATLAS-CENTAUR booster	Competing studies to be completed in November; R&D contract to be awarded 1961; first moon flights '63-'64
THOR-ABLESTAR (Air Force-NASA)	STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion	Three-stage vehicle with orbital capability of 200 lbs. New ABLESTAR upper stage has restart engine, boosts heavier payload	THOR-ABLE phased out. THOR-ABLESTAR operational in TRANSIT and COURIER
★THOR-AGENA (Air Force)	Lockheed, prime; Bell, propulsion	Two-stage vehicle capable of orbiting more than 300 lbs. AGENA-B restartable upper stage boosts payload capacity to 1250 lbs.	Operational in DISCOVERER program. AGENA-B first used May 24 to launch MIDAS II. NASA to use extensively beginning late '61
THOR-DELTA (NASA)	STL, prime; IT&T, guidance; Rocketdyne / Aerojet-General / Allegany, prop.	Improved THOR-ABLE with 480-lb. payload capability	To be used in ECHO and TIROS programs. Used successfully in ECHO I shot
★TIROS (NASA-AF-Army-Navy-Wea. Bu.)	RCA-Army Signal Corps, prime	Meteorological satellite; TV pictures of cloud cover; next TIROS to have IR Scanner	R&D; first launching in April a success; two more scheduled; second planned before end of 1960

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
TRANSIT (Navy)	Applied Physics Laboratory, prime	Navigational satellite; R&D model weighs more than 250 lbs.; operational model about 50-100 lbs.	TRANSIT IB R&D satellite put in orbit April 13; IIA plus piggyback satellite successfully in orbit June 22, four satellite TRANSIT systems scheduled operational 1962; next R&D launching late fall
TRIBE (ARPA)		Family of space launching vehicles	Planning
VOYAGER (NASA)	No contract announced	Unmanned spacecraft to orbit Mars or Venus; eject capsule for re-entry; SATURN booster	Study; first flight planned by 1965
YO YO (Navy)	No contract announced	Tactical sea-launched one-pass reconnaissance satelloid	R&D
★X-15 (NASA-AF-Navy)	North American, prime; Thiokol, propulsion	Rocket plane; 3600 mph; flight at edge of space; on AF model each XLR-11 rocket engines develop 16,000 lbs. of thrust; XLR-99 engines to develop 50,000 lbs. Three planes delivered	Powered flights in progress; plane #1 has hit Mach 3 and more than 136,500 ft. with XLR-11 engine; plane #2 undergoing flight tests with XLR-99 engine. Plane #3 undergoing repairs from June B ground test explosion

MISSILES & ROCKETS

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
ALFA (Navy)	Avco, prime	ASW surface-to-underwater; 500 lb. solid; conventional; formerly called ABLE	Deployed on destroyer escorts
★ASROC (Navy)	Minneapolis-Honeywell, prime; Sangamo Electric, Sonar; Torpedo, GE; depth charge, M-H.	Surface-to-underwater; solid rocket torpedo or depth charge; nuclear or conventional, range about 8 miles; advanced ASROC (improved torpedo) under R&D	R&D; operational on Destroyers Norfolk, Adams, Dewey and Perry; plans call for deploying on 150 destroyers and cruisers
ASTOR (Navy)	Westinghouse, prime	ASW underwater to underwater; rocket torpedo; nuclear	R&D
★ATLAS (Air Force)	Convair, prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE, re-entry vehicle	ICBM; more than 5500-to-7500 mile range; liquid; nuclear; ATLAS "E" series has inertial guidance; earlier ATLAS "D" has radio inertial	70 launchings: 45 successes, 10 partial, 15 failures; 11 scheduled sites for 13 squadrons named; operational at Vandenberg and Warren; ATLAS E tests began Oct. 11
ARM (Air Force)	No contract announced	Anti-radar missile	Studies; plan for separate missile shelved at least temporarily
BOMARC-A (Air Force)	Boeing, prime; Westinghouse, guidance; Airojet/Marquardt, propulsion	Ramjet surface-to-air interceptor; liquid booster; 200 m. range; Mach 2.7; nuclear	First squadron operational at McGuire AFB, N.J.
★BOMARC-B (Air Force)	Boeing, prime; Kearfott/Westinghouse, IBM guidance; Thiokol/Marquardt, propulsion	Ramjet, surface-to-air; solid booster; Mach 2.7; more than 500 m. range; nuclear	Air Force has accepted B's for production; a B test bird intercepted simulated target 345 miles away Oct. 14
BULLPUP (Navy-Air Force)	Martin, prime; Martin, guidance; Thiokol (Reaction Motors), propulsion	Air-to-surface; 4-B mile range; conventional 250-lb. bomb; new model has pre-packaged liquid; nuclear-tipped model under development	Deployed with Atlantic and Pacific Fleets; bigger model under R&D; Air Force buying modified version; Marines launching BULLPUP from helicopters
COBRA (Navy)	No contract announced	Anti-ship radar missile	Early R&D
COBRA (Marines)	Boelkow Entwicklungen, West Germany, prime; Daystrom, U.S. distributor	24.6-pound anti-tank missile; 1 mile range; 191 mph speed; solid propellant	Marines planning to purchase; Army considering them; already operational with West German troops
CORPORAL (Army)	Firestone, prime; Gilfillan, guidance; Ryan, propulsion	Surface-to-surface; 75-mile range; liquid; nuclear	Deployed with U.S. & NATO troops in Europe
CLAYMORE (Army)	No contract announced	Anti-personnel missile	R&D
CROW (Navy)	No contract announced	Air-to-air missile	R&D; has been flight tested
DAVY CROCKETT (Army)	In-house project at Rock Island, Ill., arsenal	Surface-to-surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers of different size for various ranges; vehicle mounted or carried by two men	R&D; operational in FY '61; first NATO deliveries also FY '61
EAGLE (Navy)	Bendix, prime; Bendix, guidance; Aerojet, propulsion; Grumman, airframe	Air-to-air; 100-mile range; nuclear; for launching from relatively-slow Douglas Missileers now under development; EAGLE is 15 ft. long; wt., about 2000 lbs., Mach 4; solid	R&D; Missileer production run reported to be 120 in next few years

★FABMIDS (Army)	Convair, Hughes, Martin, GE, Raytheon, Sylvania—feasibility studies	Mobile anti-missile defense system	Each of six contractors have $250,000 feasibility study contracts awarded Oct. 10
FALCON (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion	Air-to-air; 5-mile range; Mach 2; solid; conventional; GAR-11 has nuclear warhead	GAR-1 through GAR-4 operational; GAR-9 & 11 R&D
GENIE (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air; unguided; 1.5-mile range; nuclear	Operational
GIMLET (Navy)	No contract announced	Air-to-surface; unguided; considered highly accurate	R&D
★HAWK (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 20-mile range; solid; conventional; designed to hit low-flying planes	Operational; deployed at Panama, Okinawa; SUPER HAWK under development; Jan. 29 successfully intercepted HONEST JOHN, first known intercept of one tactical missile by another
HONEST JOHN (Army)	Douglas, prime; Hercules, propulsion	Surface-to-surface; unguided; 16.5-mile range; nuclear	Operational; deployed in Europe
HOUND DOG (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air-breathing air-to-surface; 500-mile range; Mach 1.7; turbojet; nuclear	Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400; training fully underway
★JUPITER (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion; Goodyear, re-entry vehicle	IRBM; liquid; nuclear	To be deployed with Italian and Turkish troops. 31 military launchings: 24 successes; 5 partials; 2 failures. Full tactical GSE used for first time in Oct. 20 shot from Cape
LACROSSE (Army)	Martin, prime; Federal Telecommunications Laboratories, guidance; Thiokol, propulsion	Surface-to-surface; highly mobile; 20-mile range; solid; nuclear	Operational; 4 units being trained; 3 more planned for 1960; being deployed in Europe and Far East; advanced LACROSSE R&D program dropped at least temporarily
★LAW (Army)	No contracts announced	Light antitank missile to be carried in tube	R&D under AOMC
LITTLE JOHN (Army)	Emerson Electric, prime; ABL, propulsion	Surface-to-surface; unguided; 10-mile range; solid; nuclear	Operational this year; units training with it
LOBBER (Army)	No contract announced	Surface-to-surface; cargo carrier; 10-15 mile range; also can drop napalm; LOBBER with warhead called BALLISTA	Studies
LULU (Navy)	General Mills/Naval Ordnance Lab, prime	Small nuclear depth charge air-dropped or launched by ASROC	Operational
MACE (Air Force)	Martin, prime; AC Spark Plug, guidance; Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid; nuclear; B model has 1000-m. range	Being deployed with U.S. troops in West Germany; now all mobile but hard-base version in R&D; first launched from prototype hard site in July
MATADOR (Air Force)	Martin, prime; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 650-mile range	Being turned over to West Germans; also deployed in Far East
MAULER (Army)	Convair, prime	Surface-to-air; IR guidance; highly mobile antiaircraft and antimissile missile for field use; to be on tracked vehicle; 12 missiles in each launcher	R&D; NATO may buy
★MINUTEMAN (Air Force)	Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules, third stage; Avco, re-entry vehicle; AMF-ACF rail launcher	2nd generation ICBM; solid; fixed or mobile eboard railroad trains; nuclear; 3 stages	R&D; scheduled to be operational mid-1962 at Malmstrom AFB; launching of eight tethered birds from silos successfully completed in May; first full R&D launching from Cape in Dec.; tactical rail system tests completed; first 3 squadrons at Malmstrom; Ellsworth AFB, S.D., being surveyed for more
M-55 (Army)	Norris Thermador, prime	Four-inch diameter, small, short-range poison gas rocket; to be fired from 45-tube launchers	Operational
MISSILE A (Army)	ARGMA prime	Surface-to-surface; 65-70 mile range; solid	Design studies
NIKE-AJAX (Army)	Western Electric, prime; Western Electric, guidance; Hercules Powder, propulsion	Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional	Deployed in U.S., Europe & Far East; about 170 batteries in U.S.

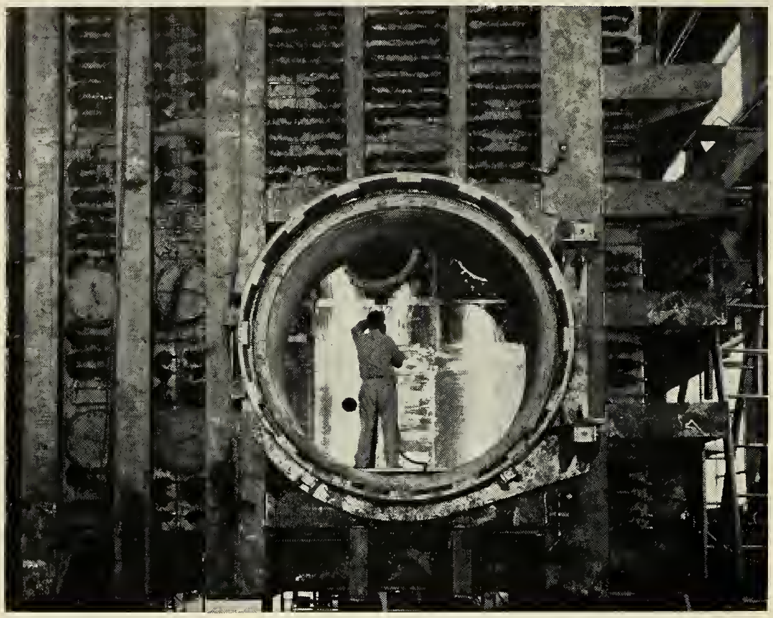
PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★NIKE-HERCULES (Army)	Western Electric, prime; Western Electric, guidance; Hercules & Thiokol, propulsion	Surface-to-air; 80-mile range; Mach 3+; nuclear; effective against tactical missiles as well as aircraft; mobile or fixed installation	Rapidly replacing NIKE-AJAX; more than 80 batteries deployed in U.S.; NIKE-HERCULES units on Formosa
★NIKE-ZEUS (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol and Grand Central, propulsion	Anti-missile; 3-stage; 200-mile range; solid; nuclear	R&D test launchings at White Sands. 10 R&D launchings: 6 successful, 3 partial, 1 failure. Complete system tests now scheduled for mid-'62
★PERSHING (Army)	Martin, prime; Bendix, guidance; Thiokol, propulsion	Surface-to-surface; two-stage solid; approx. 500-mile range; nuclear; transported on tracked FMC XM474 tracked vehicle; proposed PERSHING II would have 1000-mile range	R&D; to replace REDSTONE; 7 R&D launchings: 6 successes (all with dummy 2nd stage), 1 failure. Expected operational late 1962
★POLARIS (Navy)	Lockheed, prime; GE, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle	Underwater and surface-to-surface; solid; 1200-mile range can hit more than 90% all targets in Russia; nuclear; POLARIS II (1500-mile range) and SUPER POLARIS (2500 mile range) under R&D	87 launchings of test vehicles: 60 successes; 20 partial; 7 failures; (12 launched from submerged submarines —all cleared surface; 8 successful flights, 4 failures. First sub to be deployed by mid-November; No. 2 by end of year
RAVEN (Navy)	No contract announced	Air-to-surface; about 500-mile range	Study
REDEYE (Army)	Convair, prime; Atlantic Research, propulsion	Surface-to-air; 4-foot, 20-lb. bazooka-type; IR guidance; solid; conventional; container-launcher disposable	R&D; Marines also will use; NATO may buy
REDSTONE (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; nuclear	Deployed with U.S. troops in Europe; to be replaced by Pershing
REGULUS I (Navy)	Chance Vought, prime; Stavid, guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet & solid; 500-mile range; nuclear	Deployed aboard U.S. submarines; REGULUS II used as target drone
SERGEANT (Army)	JPL/Sperry, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; more than 75-mile range; nuclear	Production. To replace CORPORAL this year
SHILLELAGH (Army)	Aeronutronic, prime	Surface-to-surface; lightweight; can be vehicle-mounted	Early R&D
SIDEWINDER (Navy)	GE-Philco, prime; Avion, guidance; Naval Powder Plant, propulsion	Air-to-air; IR guidance; 6-7-mile range; conventional; new I-C models to have switchable IR and radar-guided warheads	Deployed with Navy and Air Force; all-weather type under development
★SKY BOLT (Air Force)	Douglas, prime; Nortronics, guidance; Aerojet, propulsion; GE, re-entry vehicle	Air-launched ballistic missile; more than 1000-mile range; solid; nuclear; to be launched from B-52, B-70 and Vulcan bombers	R&D; to be purchased by British; operational 1964-65; both U.S. and British planes to test-launch from Eglin AFB, Fla.
SLAM (Air Force)	No contract announced	Surface-to-surface; low-altitude; supersonic; nuclear-powered ramjet; nuclear	Study-R&D
★SNARK (Air Force)	Norair, prime; Northrop, guidance; Aerojet-General, propulsion	Surface-to-surface; 5500-mile range; solid and turbojet; Mach .9; nuclear	One squadron of about 20 missiles at Presque Isle, Maine
SPARROW III (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol, propulsion	Air-to-air; 5-8 mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional	Operational with carrier aircraft; earlier SPARROW I obsolete; new contract aimed at extending range and altitude
SUBROC (Navy)	Goodyear, prime; Kearfott, guidance; Thiokol, propulsion	Underwater or surface-to-underwater; 25-30 mile range; solid; nuclear	Estimated operational date: 1961. To be installed first on Thresher nuclear-powered attack submarine
SS-10 (Army)	Nord Aviation, prime	Surface-to-surface; primarily anti-tank; 1600-yards range; 33 lbs. solid; wire guided; conventional	Operational with U.S., French and other NATO and Western units; battle-tested in North Africa
★SS-11 (Army)	Nord Aviation, prime	Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs.; wire guided; conventional	Operational. Under evaluation by Army; decision on procurement due for some time
TALOS (Navy)	Bendix, prime; Farnsworth/Sperry, guidance; Bendix/McDonnell, propulsion	Surface-to-surface; 65-mile range; solid & ramjet; Mach 2.5; nuclear	Operational aboard cruiser Galveston
★TARTAR (Navy)	Convair, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional	Operational on Missile Destroyer Adams in Oct.
TERNE (Navy)	Kongsberg Vapenfabrikk, prime; Arma, systems integration	Surface-to-underwater ASW missile; 264 lbs.; 102 in. long; 105-lb. warhead	The Navy is buying the Norwegian missiles to equip two destroyer escorts
TERRIER (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	Surface-to-air; 10-mile range; Mach 2.5; 27 feet long; solid; conventional	Operational with fleet

TERRIER-ADVANCED (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	About 100% performance improvement over TERRIER	Operational Advanced TERRIERS to be deployed this year
★THOR (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE, re-entry vehicle	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear	Operational; 4 bases set up in England. 64 military launchings: 43 successes; 11 partial; 10 failures; 38 scientific launchings: 32 successful, 2 partial; 4 failures
★TITAN (Air Force)	Martin, prime; Bell/Western Electric, Remington Rand, TITAN I guidance; AC Spark Plug, TITAN II guidance; Aerojet-General, propulsion; Avco, re-entry vehicle	Surface-to-surface ICBM; 5500-mile range; liquid; 90 feet long; nuclear; TITAN I burns LOX-Kerosene; TITAN II has storable propellants, inertial guidance, bigger payload, greater range	25 launchings test vehicles: 17 successes; 3 partial; 5 failures. 9 sites for 14 squadrons named; TITAN I operational fall 1961; first Vandenberg launchings scheduled this fall; TITAN II scheduled to be operational early 1963
TYPHON (Navy)	Westinghouse, prime; Bendix propulsion	Medium and long range seagoing anti-missile missiles; formerly called SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional; supersonic	Early R&D; may be used on hydrofoil destroyers
WAGTAIL (Air Force)	Minneapolis-Honeywell, prime	Air-to-ground; low-level; solid; designed to climb over hills and trees	R&D
WILLOW (Army)	Chrysler, prime	Highly-classified missile	R&D
ZUNI (Navy)	Naval Ordnance Test Station, prime	Air-to-air, air-to-surface; solid; unguided rocket; 5-mile range; conventional	Operational

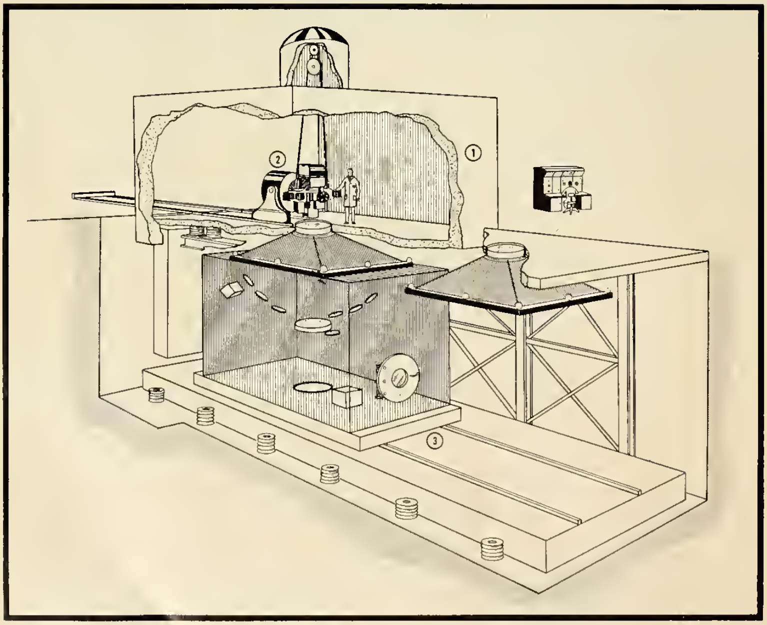
SATELLITES

SATELLITE	COUNTRY	STATUS
★EXPLORER I (30.8 lbs.)	U.S.	Launched 1/31/58, est. life 3-5 years. Orbits earth, perigee: 217 m., apogee: 1171 m., period: 108.5 min. (Discovered Van Allen Belt); not transmitting.
★VANGUARD I (3.25 lbs.)	U.S.	Launched 3/17/58, est. life 200-1000 years. Orbits earth, perigee: 408 m., apogee: 2458 mi.; period: 133.9; still transmitting.
★LUNIK I "MECHTA" (3245 lbs.)	RUSSIA	Launched 1/2/59. Believed to be in orbit around sun on 15 mo. cycle; not transmitting.
★VANGUARD II (20.7 lbs.)	U.S.	Launched 2/17/59, est. life 10 years +. Orbits earth but is "wobbling," perigee: 350 m., apogee: 2042, period: 125.3 min., inclination to equator: 32.88°; not transmitting.
PIONEER IV (13.40 lbs.)	U.S.	Launched 3/3/59. Orbits sun, and achieved primary mission, an Earth-Moon trajectory; not transmitting.
EXPLORER VI "PADDLE-WHEEL" (142 lbs.)	U.S.	Launched 8/7/59, est. life: to Aug. 1961. Orbits earth, former perigee: 156 m., former apogee: 26,357 m., former period: 12½ hours, present orbit unknown; speed: at perigee 23,031, at apogee 3126 mph., inclination to equator: 46.9°; not transmitting.
★VANGUARD III (about 100 lbs.)	U.S.	Launched 9/18/59, est. life 30-40 years. Orbits earth, perigee: 320 m., apogee: 2318 m.; period: 129.8; not transmitting.
★EXPLORER VII (91.5 lbs.)	U.S.	Launched 10/13/59, est. life 20 years, orbits earth, perigee: 344, apogee: 671; period: 101.2; transmitting.
★DISCOVERER V CAPSULE (less than 300 lbs.)	U.S.	Launched 8/13/59. Satellite burned up in atmosphere Sept. 28. Capsule also thought to have been destroyed, but it was later rediscovered and first thought to be an unidentified Soviet satellite. Est. life several months; period: 96.5; perigee: 123, apogee: 607.
★PIONEER V (94.8 lbs.)	U.S.	Launched 3/11/60, est. life: forever; orbits sun, interplanetary radio communication satellite, passed 20 million miles June 20; not transmitting.
★TIROS I (270 lbs.)	U.S.	Launched 4/1/60, perigee: 428.9 m.; apogee: 468.1; period: 99.1 Picture-taking weather satellite; still transmitting.
★TRANSIT IB (265 lbs.)	U.S.	Launched 4/13/60, est. life: 16 mos. minimum; perigee: 237.7; apogee: 433; period: 95.4. First R&D navigation satellite. Not transmitting.
★SPUTNIK IV (10,008 lbs.)	RUSSIA	Launched 5/15/60; est. life: relatively brief; original perigee: 188; apogee: 229; changed to 191/429 on May 19. Last reported—Period: 93.6; perigee: 175; apogee: 384. Test of support systems, cabin, for manned space flight; attempt to return from orbit failed because of poor orientation of retrorocket.
★MIDAS II (5000 lbs.)	U.S.	Launched 5/24/60; est. life: 40 months; perigee: 300.1; apogee: 316; period: 94.4; Telemetry for IR scanning failed two days after launch; still transmitting.
★TRANSIT II-A (223 lbs.)	U.S.	Launched 6/22/60; est. life: 50 years; period: 101.7; perigee: 389.2; apogee: 650.5; still transmitting.
★NRLI "GREB" (40 lbs.)	U.S.	Launched 6/22/60 with TRANSIT II-A; period: 101.7; perigee: 657.8; apogee: 657.8. Solar radiation measuring satellite; still transmitting.
★DISCOVERER XIII (1700 lbs.)	U.S.	Launched 8/10/60; period: 94; perigee: 153; apogee: 267; 300-lb. capsule successfully ejected from orbit and recovered from Pacific 8/11—the first satellite to be recovered from orbit.
★ECHO I (132 lbs.)	U.S.	Launched 8/12/60; est. life: one year; period: 117.8; perigee: 781; apogee: 1192; first successful orbiting of a passive communications satellite.
★COURIER IB (500 lbs.)	U.S.	Launched 4/10/60; period: 106.9; perigee: 586; apogee: 768; first successful launching of a delayed active repeater satellite; est. life one year

Unique Environmental Center Goes up at Fairchild



VIEW OF five-foot access door leading into the 2825-cu.-ft. altitude chamber. Snake-like coils on wall can furnish up to 360 BTU/sq. ft./hr. of radiant heat.



ENVIRONMENTAL FACILITY includes (1) altitude chamber, (2) track-mounted vibration machine, and (3) track-mounted collimator-systems chamber. Optical window is in floor of (1), image splitter below it and optical mirror in floor of (3).

by William Beller

SYOSSET, NEW YORK—Early next year an advanced facility will be testing high-performance photographic systems in a simulated space environment. It is probably the only environmental facility in the world designed specifically for optics work.

Fairchild Camera and Instrument Corporation is building it in-house. Price tag is $1.7 million.

The investment is being made partly because of the space-age trend toward small total production of new and unique photographic designs, where often the prototype test is also the operational one. Consequently, final evaluation and debugging becomes a laboratory operation.

Other expected dividends will be extensive design data, improved system reliability by having such data, and near-complete performance testing under simulated flight conditions.

When it is finished, Fairchild says, the facility will be capable of resolution testing very long focal length, large relative aperture, diffraction-limited photographic sensors. It will be able to test these sensors under many environmental profiles of space vehicles. For this purpose, the controlled parameters will be pressure, temperature, humidity and vibration.

• **Moving "target"**—The test center is divided into an upper and a lower chamber. The upper (15 ft. x 13 ft. x 14 ft.) is the altitude chamber, which contains the vibration equipment and the optical unit undergoing test. The pressure can be brought down to 1.3×10^{-8} mm Hg, the temperature can range between −100°F and 200°F, the relative humidity can be varied between 5% and 95%, and the vibration machine can put out a maximum sinusoidal force of 28,000 pounds.

The lower chamber holds the collimator system. This comprises a vertical 36-in. parabolic collimator of 27-ft. focal length. The system goes 34 feet below ground level and is used with seven additional collimators and an image motion compensation system.

This system includes a simulated moving target put in by a film strip, which is expected to be extremely useful for testing the resolution of reconnaissance systems while in flight.

Equipment in the company's present environmental test facility, also located in the Syosset plant, will complement the new test center. This equipment includes walk-in temperature, humidity, rain and fungus chambers; smaller altitude chambers; salt spray equipment; an explosion chamber and a large centrifuge for G-force testing.

Sea Raises Peculiar Design Problems

Designers must keep in mind destructive effects of ocean water and sea life and varying levels of operation

by Leslie E. Alsager
Supervisory Marine Engineer
Bureau of Ships

Third in Series

This is the third in a special series of articles intended to acquaint readers with the nature of the submarine threat, the ASW engineering problems involved, and the means or lack of means for solving them. Written by authorities in the ASW field, future articles will deal with sonar, hydrodynamics, oceanography and ASW weapon systems.

UNIQUE TECHNICAL PROBLEMS confront the engineer who newly enters the ASW field from the aircraft or spacecraft field.

He suddenly finds himself working with a relatively dense fluid medium, where such things as temperature and salinity distributions are variable, almost capricious.

He finds other problems. The organisms that abound in the sea can score a vessel's hull or confound the craft's detection equipment. The strength of most materials decreases and human factors problems increase.

Submarines are designed to operate while on the surface, at periscope or snorkel depth, and in a fully submerged condition. Therefore, in developing the parametric studies of design, engineers must consider each of these three conditions of operation in order to provide an adequate vessel.

Surface operation of a submarine lends itself to a design similar to that of a surface ship. Since submarines generally are configured as a body of revolution with no large dominant keels or stabilizers, surface operation is the least attractive with respect to crew comfort. In addition, heavy rolling and pitching in a seaway make machinery and equipment design difficult.

Roll and pitch specifications for surface operation may require 60° roll at low power and 30° roll at high power. These degrees are measured from the vertical and are assigned a complete roll cycle (from one extreme to the other and back) of about 8 seconds. Pitching of the ship in the surface conditions may be assigned values of 10° from the horizontal plane with a complete pitch cycle of about 6 seconds.

Unfortunately, no ship operating in a seaway can be expected to have a pure rolling motion or a pure pitching motion. Thus the designer must provide an installation that will perform under combinations of these inclinations.

• **Underwater criteria**—Periscope or snorkel depth is a sub-surface operation. This depth does not permit full exposure of the submarine. However, it does permit ship operators to make visual examination of the sea surface and celestial observations by the periscope.

The snorkel can provide replenishment of air within the ship or an air supply for fuel-burning equipment such as a diesel engine. Here, again, the ship is subject to dynamic forces resulting from surface sea conditions. However, masts, superstructures and other protuberances provide resistance to rolling motions; hence the roll condition can be expected to decrease. Since any of these cycles can be expected to vary with the particular ship, engineering judgment in assigning design numbers must prevail.

Submerged depth is often defined as "way deep" in the sea. From a designer's standpoint, submerged operation denotes the condition where the submarine is a self-contained operating body and where no contact can be made with the surface through either periscope or snorkel. A submerged submarine generally can be considered a stable platform, reasonably unaffected by surface sea conditions. However, owing to maneuvering conditions and low speeds where currents are involved, the designer must establish conditions of dive angles, roll angles and other hydrodynamic parameters. Again, these are ship-design-dependent. For early design consideration, this set of conditions could be used:

(1) A roll 30° from the perpendicular with a complete roll-cycle period of 12 seconds, and a pitch of 10° with a complete pitch-cycle period of 60 seconds.

(2) A so-called trim on the ship can be calculated and would be dependent on the apportionment of weights throughout the ship. A satisfactory trim is defined as a trim obtained after submerging and with the ship on an even keel where this even keel can be maintained at the desired depth and at all speeds with minimum use of the ship's planes. In a rise or dive attitude, however, this trim could result in design angles of 30°; and angles as great as 40° have been observed.

Submersible-weapon designers when selecting materials must recognize the (1) Corrosion-erosion effects of sea water; (2) Galvanic effect of sea water; (3) Effect of biological organisms on the hull and equipment; (4) Effect of sea water on the strength of materials.

• **Corrosion-erosion effects**—Corrosion of hull, piping, or machinery can lead to failure. Some confusion always exists as to whether the failure can be attributed to corrosion or erosion or to both.

Generally, the effects can be ameliorated for a specified life by correct control of design velocities, selection of materials, attention to system detail, and by recognizing the environment to which the equipment is used.

The Navy has conducted many investigations into corrosion-erosion effects. Paralleling the Navy work is an extensive program by the International Nickel Company in its research laboratories at Kure Beach in North Carolina. LaQue and Mason (see Bibliography)

film barriers give some protection . . .

in 1950 presented an excellent paper on 70-30 cupro-nickel alloy and its resistance to corrosion and erosion. Cupronickel is used extensively in the United States for sea-water systems because of its excellent corrosion and erosion-resistance for moderate flow velocities.

Stainless steels maintain an oxide film (which is self-repairing) and hence provide excellent corrosion resistance to sea water in flowing waters. Severe pitting has been reported when the material was used in stagnant waters or in equipment containing crevices in which there was no flow.

The austenitic stainless steels appear to be susceptible to stress corrosion cracking in moderate-to-high-temperature chloride water environments. Some compositions, for example AISI 304, 316, and 347, are considered to be more susceptible than others. The subjects of stress corrosion has not been explored as extensively as might be desired. However, it is believed that where the steels are subjected to wetting and drying, are at moderate-to-high temperatures, are under stress and are in the presence of oxygen, susceptibility to stress corrosion cracking is possible. This type of stress failure can be reproduced in a short period of time and must be considered when selecting materials.

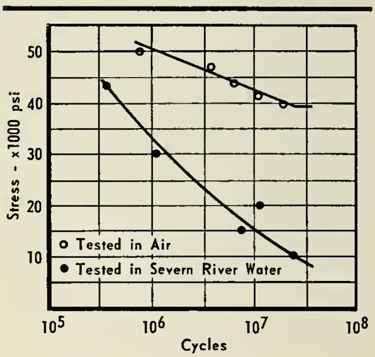
While material selection is primary, film barriers such as paints, oils, grease or some other type of coating will help to reduce the rate of corrosion provided they are properly applied and maintained.

- **Galvanic effects**—Here is an electro-chemical type of reaction where the salt water acts as an electrolyte. Where there are two dissimilar metals in contact or in close proximity in an electrolyte, a current will flow and decomposition of the less noble metal will result. Through satisfactory selection of materials, and size of materials or use of waste pieces (zincs, for example), a designer can usually combat this type of corrosion.

- **Effect of biological organisms**—Marine organisms are normally considered to be a cause of interruptions to flow. Such interruptions create turbulence in a velocity profile with consequent impingement of the fluid on the surface downstream of the organism. This impingement literally wears away the surface. Further, marine organisms assist in forming corrosion cells.

The subject of marine growth on the surface of equipment and in internal areas of piping systems such as in sea water piping must be considered. Dead-end pockets where no fluid flow is anticipated must be avoided. Film barriers such as paint with poison additives can help, but these film barriers must be properly maintained. Judicious selection of materials and flow velocities for the systems is required. No practical method of overcoming this problem is known, but the above suggestions can assist in alleviating it.

- **Strength of materials**—Generally, it is economically wise to follow industry codes for material selection and fabrication. These codes are reviewed periodically and kept up to date by interested activities. The departure from the industry codes, however, becomes necessary where the material is in intimate contact with sea water.



ALTERNATING torsion fatigue test curves.

Early information and bibliographies on fatigue and corrosion fatigue of ferrous and non-ferrous materials are given in a Gough and Sopwith paper presented in 1937 and McAdams paper presented in 1929. Some later information may be found in the LaQue and Mason paper.

It is important to realize that many materials, particularly carbon and low alloy steels, tend to have reduced fatigue strength in sea water. The accompanying figure shows a curve of endurance and corrosion-fatigue-test results from specimens subjected to cycles of completely reversed stress in alternating torsion. These tests were made with low-alloy, nickel-chrome-vanadium-molybdenum rolled steel specimens which had an average tensile strength of 140,000 psi and an average yield strength of 118,500 psi. The Severn River water mentioned is of a brackish type having a salt content of 1/6 to 1/3 (averages about ¼) that of sea water, depending on the season and the tides.

- **Ocean temperatures**—Design of the machinery plant, heating and cooling equipment and certain hull appurtenances must take into consideration sea water temperatures. The highest sea water temperatures occur generally at the sea surface in equatorial regions, roughly between 15° N. and 10° S. Temperatures here range from above 77°F to generally not more than 85°F; in the Persian Gulf, however, water temperature may exceed 90°F.

Lowest temperatures, less than 32°F and as low as 28.5°F, occur at the surface in Arctic and Antarctic waters during winter. In summer, cold water will also be present at the surface in the vicinity of pack ice. Cold water may persist at depths of 100 to 500 feet. No significant amounts of water with temperatures higher than 38°F are present at depth in these regions.

- **Testing for sea water effects**—For studying effects of the ocean environment, test laboratory scientists may have to synthesize ocean water. This is usually done on the basis of control of chemical composition and the concentration of those ions which are important to corrosion processes. The Naval Research Laboratory Report on Synthetic Ocean Water contains an excellent bibliography on this subject and recommends a formula for ion concentrations for use where spray conditions or high velocity impingement attack could occur. LaQue in his paper on corrosion and corrosion testing techniques also presents an excellent treatise and bibliography on this subject.

- **Internal environment**—Habilitation conditions and working arrangements for the ship's forces often cause conflict between the naval architect's concept of what the ship configuration should be and what the naval engineer believes he must have in the way of equipment.

In a surface ship, it is often acceptable to use ventilating equipment which takes its air directly from the atmosphere and returns it to the atmosphere. Obviously, this technique cannot be used aboard a submerged weapon.

Where personnel are not on board, the submersible ventilation may impose a lesser problem than for a design where the personnel are on board. In the first case, the design may make effective use of the ocean as a cooling medium, conducting the heat of the heat-generating equipment to the ocean. The problem may resolve into controlling the humidity to obtain satisfactory operation of the equipment.

Where the human is to work and live abroad a submersible weapon, air-conditioning is needed. It denotes besides heating and cooling the following: (1) oxygen control, (2) removal of noxious gases, (3) dehumidification, (4) selection of equipment, (5) hull insulation, (6) recognition of the activity areas of the personnel, and (7) recog-

At $00^h 00^m 01^s$ GMT, November 1, 1960, Martin logged its 724,620,000th mile of space flight

TITAN—*50 miles up: Official USAF Photo*

Air Force-Martin Titan, *giant American ICBM, has been chosen for a key role in space exploration. One of its first missions will be to launch USAF Dyna-Soar — manned aerospace craft.*

MARTIN

1961 MEDIA PLANNING GUIDE

missiles and rockets

5 Issues with SPECIAL Editorial Emphasis

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May 29, 1961—RESEARCH AND ENGINEERING ISSUE: a projection of developments in research and engineering in the missile/space field, including coverage of propulsion, guidance, materials and ground support equipment.

July 17, 1961—MISSILE/SPACE ENCYCLOPEDIA ISSUE: a description, picture and diagram of each of the missile systems of the United States and known international systems, including specifications, services and companies involved . . . also contains a section describing rocket engines of the world . . . the most widely accepted source of missile information in use today.

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missiles and rockets

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nition of air pressure changes on the inside of the hull of the vessel.

• **Vibration and noise**—Where personnel must eat, sleep, and work for long periods of time, airborne noise and vibration of equipment in the ship plays a significant role in the crew's combat effectiveness.

Vibration of any type has its own noise level and generally can be considered as the main source of airborne noise. Noise generated by the crew, except for specific spaces in the submarine where quietness is enforced, can usually be ignored in establishing airborne noise criteria.

Vibration occurs as a result of unbalance of equipment, frequency resonance with an associated piece of equipment or the hull, high-velocity impingements of flows causing excitations, electrical, mechanical and hydraulic circuit fluctuations and from other sources. Often the vibration with its attendant exciting forces can be corrected or alleviated through correct design or redesign, or through the use of noise traps.

There is another far-reaching consideration for combat effectiveness which transcends most other considerations and makes the military weapon more or less effective as a combat weapon. This s the noise emanating from the ship to he enemy equipment attempting to de- ect the weapon (radiated noise), or rom the machinery to the weapon's wn listening equipment (self noise).

Self noise is that noise which inter- eres with the listening or detection apabilities of the ship. This factor im- oses upon the machinery designer the esponsibility for designing his equipment around the frequency spectra of is listening or detection equipment.

From a practical standpoint the hip's machinery and detection gear de- gns must be integrated with certain pecific frequencies eliminated from the hip's spectra and other frequencies educed in noise level so that this detec- on gear is not effected. Where many ifferent types of detection gear are in- alled, this restriction imposes a tough ngineering problem.

Radiated noise is generated by the hip's machinery and equipment and oes into the water, permitting detec- on by an enemy device. Here, as with lf noise, the airborne noise must be onsidered. Further, that noise emanat- g from sea-water-connected systems, om machinery foundations, from hull- onnected equipment and from hydro- ynamic sources plays a significant role resolution of the ships design. Bal- ncing equipment, streamlining hydrody- mic systems and appurtenances, and cluding sound traps all take part in ducing the radiated noise level.

Nothing has been said here about propulsion, electronics and fire power. These are more questions in the large sheaf of problems that confront the engineer in the ASW field. Oddly enough, even as solutions come to ASW problems, the size of the sheaf never lessens but simply changes character.

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Saturn Stand

Aetron Wins Contract For Second Facility

Aetron Division, Aerojet-General Corp., will engineer and design the second *Saturn* test stand to be constructed at Huntsville, Ala.

Marshall Space Flight Center, National Aeronautics and Space Administration, announced last week that Aetron was chosen from 25 architect-engineer firms bidding on the job.

The ultimate cost of the test facility will be $10.8 million. However, Aetron will perform at the beginning only the design and engineering phase of the work. Construction contracts will be awarded later.

The second facility will enable the Marshall Center to conduct two static booster firings within a short period of time. Because of the complexity of the booster and its test-recording equipment, lengthy preparation is needed for each series of tests. When *Saturn* flights reach the rate of four or five a year, the second stand will be needed to avoid delay.

The design-engineering phase of the job is expected to take seven months. After that, the Marshall Center will approve the final design and call for construction bids.

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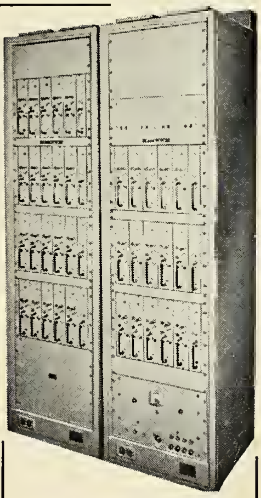

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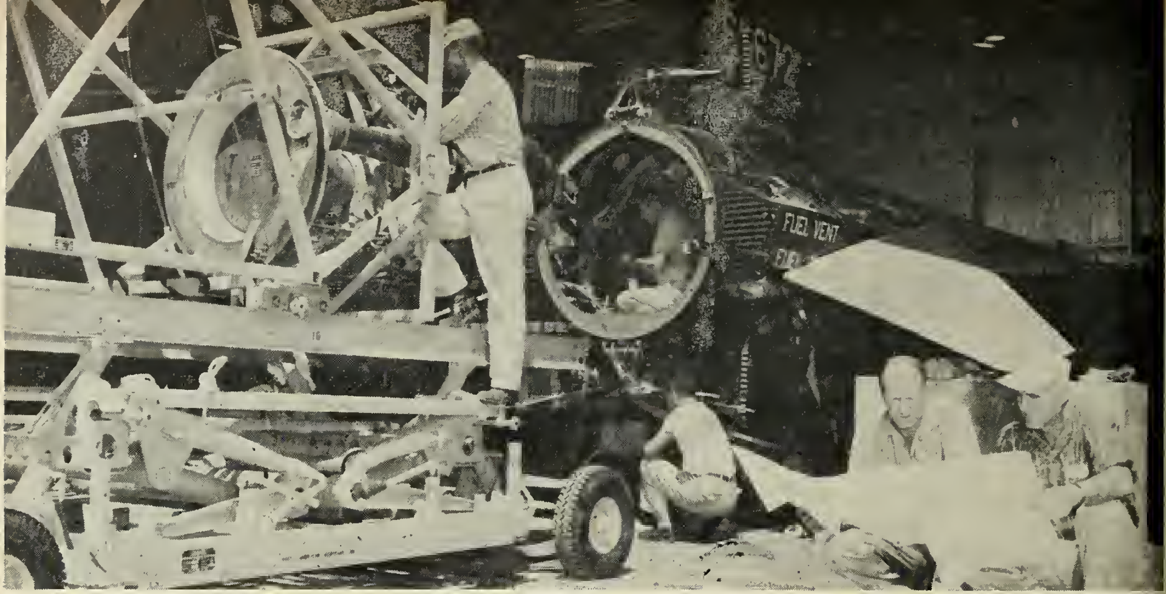

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Flight Set For XLR-99 Engines

FIRST FLIGHT TESTS of the *X-15* with its new XLR-99 "man-rated" engine scheduled for last week were designed to check out stop-start operations in actual flight. No speed or altitude records were on the fire. Later tests with the new engine are expected to boost the NASA research rocket ship up to altitudes of at least 100 miles and to speeds of 4000 mph.

Three of the new engines have already been delivered to Edwards AFB. The first has exceeded its allowed 30-minute running time in ground tests and is being overhauled. The number two engine is the first scheduled for flight.

The XLR-99 is the only rocket engine designed to be directly controlled by a pilot. It can be throttled from 25,000 to 50,000 pounds thrust and is capable of up to five start-stop operations in flight. In case of a malfunction, the engine automatically shuts down. After a stop, the pilot throws a switch to purge the system, then can restart at will.

Designers of the XLR-99 foresee its use in even more advanced space missions. They say its thrust and control capabilities fit it for such flights as orbiting *Dyna-Soar* type vehicles or even soft-landing and returning a man from the moon. ⁂

X-15 Flight Record

Date	Flight*	Pilot	Max. Alt.	Max. Mach	Remarks
Mar. 10, 1959	1-C-1	Crossfield	38,000	.80	B-52-X-15 Power Loss
Apr. 1, 1959	1-A-2	Crossfield			Lack in N_2 Line
Apr. 10, 1959	1-A-3	Crossfield	45,000	.80	Both APU's Failed
May 21, 1959	1-A-4	Crossfield			APU Bearing Overtemp
June 8, 1959	1-1-5	Crossfield	37,000	0.80	Glide
July 24, 1959	2-C-1	Crossfield			Fully Fueled
Sept. 4, 1959	2-A-2	Crossfield			LOX Pressure Reg Failed
Sept. 17, 1959	2-1-3	Crossfield		2.3	1st Powered
Oct. 10, 1959	2-A-4	Crossfield			No LOX Top-Off Press
Oct. 14, 1959	2-A-5	Crossfield			LOX Press Reg & Vent Valve Failed
Oct. 17, 1959	2-2-6	Crossfield	65,000	2.3	
Oct. 22, 1959	2-A-7	Crossfield			B-52/X-15 O_2 Select Valve Seized
Oct. 31, 1959	2-A-8	Crossfield			Weather
Nov. 5, 1959	2-3-9	Crossfield			Engine Explosion, Emergency, Damage Slight
Dec. 16, 1959	1-A-6	Crossfield			Low LOX Pressure
Jan. 23, 1960	1-2-7	Crossfield	65,000	2.0	
Feb. 4, 1960	2-A-10	Crossfield			No Fuel Pressure
Feb. 11, 1960	2-4-11	Crossfield	86,000	2.15	
Feb. 17, 1960	2-5-12	Crossfield	50,000	1.6	
Mar. 17, 1960	2-6-13	Crossfield	50,000	2.1	
Mar. 18, 1960	2-A-14	Crossfield			Fuel Leak
Mar. 25, 1960	1-3-8	Walker	48,500	2.0	
Mar. 29, 1960	2-7-15	Crossfield	50,300	2.0	
Mar. 31, 1960	2-8-16	Crossfield	50,000	2.0	
Apr. 13, 1960	1-4-9	White	48,000	1.9	
Apr. 19, 1960	1-5-10	Walker	60,000	2.6	
May 5, 1960	2-A-17	Crossfield			No Start #1 APU
May 6, 1960	1-6-11	White	60,800	2.2	
May 12, 1960	1-7-12	Walker	78,000	3 +	Remote Launch
May 12, 1960	1-8-13	White	107,000	2.2	
May 26, 1960	2-9-18	Crossfield	50,000	2.0	
May 27, 1960	1-A-14	Walker			Telemetry Failure
June 3, 1960	1-A-15	Walker			#2 Hyd Press Low
June 8, 1960	1-A-16	Walker			Source Press Low
Aug. 4, 1960	1-9-17	Walker			2,196 MPH (Speed Record)
Aug. 11, 1960	1-A-18	White			Gaseous Nitrogen Loss
Aug. 12, 1960	1-10-19	White	136,500		Altitude 136,500 (Altitude Record)
Aug. 18, 1960	1-A-20	Walker			#1 APU Malfunction
Aug. 19, 1960	1-11-21	Walker			
Sept. 23, 1960	1-A-22	Peterson			Fuel Problem
Oct. 20, 1960	1-12-23	Peterson			Familiarization

*CODE FOR FLIGHT NUMBERING

First No. is Aircraft S/N.
Middle No. is number of successful flights.
Last is total.

A = Aborts.
C = Captives.

Tough Standards Set for NASA Craft

JPL calls for drastic jump in electronic performance on unmanned vehicles by 1962; stresses solar cells for auxiliary power

by William J. Coughlin

PASADENA, CALIF.—Jet Propulsion Laboratory has laid down severe performance requirements for instrumentation and other electronic and electrical equipment aboard NASA's unmanned space vehicles, calling in some cases for improvements of a full order of magnitude within two years.

Walker E. Giberson, chief of the guidance and control division at JPL, which directs NASA's unmanned lunar and planetary exploration programs, has outlined for industry future guidance and control requirements in regard to sensors, actuators and power equipment, taking as a base the equipment for the lunar impact vehicle *Ranger*, due for its initial test launch n mid-1961. His presentation was made at the recent NASA-industry conference here (M/R, Oct. 31, p. 5).

Severity of the NASA requirements can be judged by a comparison f performance for *Ranger* against uture needs for the *Surveyor* and *Prospector* moon vehicles and *Mariner* nd *Voyager* interplanetary explorers. *Ranger* is equipped with a sun sensor ith angular deviation from line toard the center of the sun of 0.1°. This must be improved to 0.01° by 962 and 0.001° by 1964. A *Ranger* yroscope sensor provides a short-term eference during commanded turns of he spacecraft away from celestial eferences with an error of no more han 0.2°/hr. JPL says this must be mproved to 0.001°/hr. by 1964-65.

The dates given are those by which PL hopes to have an operating prototype which could with minor changes ecome a production item.

In the actuator field, present gyro erformance requirements call for ass unbalance and mass stability haracteristics of 0.2°/hr./g. NASA ants this improved to 0.1 by 1962 nd 0.05 by 1964. Restraint stability of 0.1 must be improved to 0.05 by 1962 and 0.01 by 1964.

• **It can be done**—Considering developments of the past two years, Giberson feels fairly confident the requirements laid down for two years from now can be met. He also foresees other rapid advances.

"Pulse torquing of accelerometers and digital output of optical and inertial sensors is something that has to be pushed to get away from analog converters," he insists. "Then come digitized actuators so we can go directly from the computers to the actuators. This, I think, will be a requirement for future spacecraft."

Extremely sensitive micro-accelerometers will be needed by NASA by the middle of this decade, Giberson said, citing ranges of 3 x 10^{-9}gs and a dynamic range of 10^5.

"How do you protect this delicate mechanism during high acceleration and decelcration?" he asked. "This is going to be a requirement when you start talking about electrical propulsion systems on spacecraft. You have to be able to measure the acceleration."

• **Stress on solar cells**—In the power field, solar cells with a 15% efficiency, developing 6-7 watts/lb. and costing one-fifth of the present price are needed by NASA, Giberson reported. Batteries will be required with 150 stand-by life-days at 80°F and 100 watts/hr./lb. This compares to 30-60 life-days and 50-80 watts/-hr./lb. at present.

Observers attending the meeting expressed surprise at the 10-year program's emphasis on solar cells for auxiliary power, when the series of nuclear SNAP units now under development by NASA and AEC are expected to be in use beginning in 1963, with a 35-kw. unit becoming available two years later. Giberson pointed out that the "next big step beyond photovoltaic cells is the SNAP reactor, and possibly fuel cells," but

Guidance and Attitude Control Sensors

SENSOR	MEASUREMENT	RANGER	FUTURE NEED	
			PERFORMANCE	DATE
SUN	ANGULAR DEVIATION FROM LINE TOWARD CENTER OF SUN.	0.1	0.01 deg. 0.001 deg.	CY-'62 CY-'64
PLANET SENSOR ALTITUDE CONTROL	ANGULAR DEVIATION FROM CENTER OF RADIATION OF A PLANET.	0.2	0.01 deg.	CY-'62
PLANET SENSOR GUIDANCE	ANGULAR DIAMETER AND DEVIATION FROM TRUE CENTER OF A PLANET. LONG RANGE		0.01 deg. 0.001 deg.	CY-'62 CY-'64-'65
HORIZON SCANNER	ANGULAR DIAMETER AND DEVIATION FROM TRUE CENTER OF A PLANET. LONG RANGE		0.1 deg. 0.01 deg. 0.001 deg.	CY-'64 CY-'62 CY-'64-'65
STAR	ANGULAR DEVIATION FROM A STAR.		0.01 deg. 0.001 deg.	CY-'62 CY-'64-'65
GYROSCOPE	(1) SHORT-TERM REFERENCE DURING COMMANDED TURNS OF SPACECRAFT AWAY FROM CELESTIAL REFERENCES. (2) ANGULAR RATES OF TURN.	0.2/hr	0.001°/hr	CY-'64-'65

Gyro Performance Requirements

CHARACTERISTICS	REQUIRED PERFORMANCE		
	PRESENT	1962	1964
MASS UNBALANCE	.2°/hr/g	0.1	0.05
MASS STABILITY	.2°/hr/g	0.1	0.05
REACTION TORQUES	.7°/hr	0.2	0.1
REACTION STABILITY	.2°/hr	0.05	0.01
RESTRAINT TORQUES	.1°/hr/mr	0.05	0.01
RESTRAINT STABILITY	.1	0.05	0.01

indicated that solar cells would be retained until the SNAP series definitely is proven.

JPL apparently then will re-design its payloads around the SNAP units, which will provide more reliable and higher power for longer periods of time. SNAP 10, available in 1963, will weigh 300 lbs., without shielding, a big disadvantage for a system with a total payload weight of 50 lbs. *(Ranger)*, or 100 lbs. *(Surveyor)*. Future payloads of greater weight will undoubtedly use SNAP systems when their feasibility is established.

• **Big changes later**—SNAP proponents pointed out, however, that firming of payload instruments, design and power requirements now will mean extensive modification later. Payload balance, power available and scientific capability all depend on the type of system installed, they noted, and a change from solar cells to SNAP, with 10 times the power output, could drastically affect the mission.

Giberson said inverters and converters will be required, under present programing, with an output of 7-15 watts/lb. (compared to 3-7 today), an efficiency of 80-90% (compared to today's 70-85%) and regulation of 0.1-0.57% (compared to 1%).

Most critical problem for all equipment is the necessity for satisfactory unattended performance over long periods of time. To achieve this, suppliers will be expected to use present day production techniques and present day components wherever possible.

• **Breakthroughs sought**—Giberson said that while every effort will be made to maintain a step-by-step advance with proven equipment, technological breakthroughs are needed in three areas:

–A small, high-efficiency hot-gas mass expulsion system is required which will operate with high reliability.

–An attitude control system is needed which will operate in two modes—cruise mode and trim mode. Cruise control would depend on a mass expulsion system; trim control would require a precise attitude system depending on flywheels or similar devices. JPL is interested in the early availability of a reliable and simple momentum interchange device, such as a sphere, which could replace a three-flywheel system. This is desired for the 1962-64 period although it would be used earlier if developed.

–Complex computers are required which will be capable of operating throughout mission flights of 16,000 hrs. These computers will have to solve navigation equations, control sequencing and timing, operate scientific instruments and carry out data processing. Equipment of this capability will have in the neighborhood of 10,000 active components. JPL hopes for a computer with an overall 99.9% chance of surviving for the lifetime of the mission. Lacking this, individual components will be needed of 50-70,000 hrs. life. A self-healing design would offer obvious advantages.

"At the moment," Giberson said, "we have to hold down the functions of our spacecraft so we can handle them with current technology. This computer breakthrough is the one most required in terms of impact on the space program."

• **Farther on**—Giberson also outlined future guidance and control requirements for the JPL vehicles to be operational by 1970.

Ranger, boosted by an *Atlas/Agena B* combination, will be equipped with a limited-range earth sensor to direct its high gain antenna. The interplanetary *Mariner* vehicle to be used for exploration of Mars and Venus, employing an *Atlas/Centaur* launch vehicle, will require an extended-range earth seeker, probably a visual optical device similar to that of *Ranger*, which is designed around three photomultiplier tubes.

In addition, *Mariner* will require a planet seeker or tracker to direct scientific instruments to the geometric center of the planet under exploration. This is expected to be an infrared or visual optical device which will operate in the region from 300,000 km. down to 6000 km. above the planet's surface.

The Mars *Mariner*, which will follow the Venus *Mariner* in the program, will demand another major increase in capability with the addition of planetary approach guidance. For this, long-range earth sensors will be replaced by solar and star trackers. Stars such as Canopus will be used to establish a reference for roll, principally for directing the antenna.

Accurate approach guidance for the JPL interplanetary vehicles is considered a must, due to plans for near-misses and orbiting of both Mars and Venus. Some form of terminal guidance will be required so these vehicles can hit specific corridors in the vicinity of the planets. This means instruments with accuracies of 5-10 secs. of arc, says Giberson.

• **Planetary orbit**—There are no plans at the moment for an orbital *Mariner*, although this may be attempted in the later stages of the program. *Voyager*, using the *Saturn* booster, now is scheduled as the only planetary orbital vehicle. A planetary horizon seeker will be required for *Voyager* (and perhaps the advanced *Mariner*) capable of operation between 100 km. and 200 km. above the surface.

Planetary landings will require terminal phase guidance into the proper corridor, stabilization of vehicle attitude for atmospheric penetration, firing of additional retro rockets or release of parachutes as required, and possibly use of radar Doppler altimeters if an attempt is made to hit a specific landing site.

JPL also is seeking advanced guidance and control instrumentation for its moon-crawlers and planet-crawlers.

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soviet affairs

By Dr. ALBERT PARRY

Space-Age metallic elements

are mentioned in the Soviet press rather infrequently, but we know they are very much on the agenda of Russian geologists sent out on surveys and of Russian scientist and engineers engaged in the processing of what they call "rare and disseminated elements." The official list of these elements, issued in 1956 by Peter Antropov, the Soviet Minister of Geological Survey, stresses beryllium, lithium, zirconium, niobium, tantalum, gallium, germanium, and indium. In his 1956 report Antropov said that these metals "are inseparably connected with technical progress" since they "possess very important properties making them indispensable in modern atomic and jet-propulsion technique, as well as in wireless engineering, automation, and telemechanics."

The complex mineralogical composition

of these metals, Antropov remarked in his report, "makes the extraction of all their valuable components the more difficult." Yet, from time to time, Moscow announces that it has scored successes with such extraction. On July 1, 1960, *Pravda* declared that cobalt "purer than gold" was achieved for the first time in history in the Soviet Arctic metal factory at Norilsk, and that a semiautomatic installation was completed there to produce such cobalt in quantity. Another accomplishment, with indium, was reported from Siberia in *Komsomolskaya Pravda,* Sept. 22, 1960. Proceeding from the premise that indium is absolutely indispensable in making semiconductors—and highly desirable in other rocket-age production, also that foreign admixtures in indium are allowable in quantities not higher than 0.0001%, Soviet scientists claim that they achieved this purity of indium some 17 months ago in the laboratories of the State Institute of Rare Metals in Moscow.

Actual production of such pure indium

was then entrusted to the Novosibirsk Tin Plant. But here came a snag: technologists of this Siberian plant declared that the indium-bearing ore at their disposal was of a character "where the Moscow laboratory experience could not be applied." The plant's chief engineer, P. P. Pul'kin, and his staff spent months evolving their own techniques of achieving pure indium. They finally succeeded in producing what is now proudly called "Five Nines Indium"—a result containing 99.999% of indium. An official Soviet statement in late September announced that "the Novosibirsk plant will shortly begin the actual production of this rare metal so needed by the nation."

An intriguing forecast

of rare-metal mining in the future was contained in *Komsomolskaya Pravda* for Oct. 4, as that paper celebrated the third anniversary of the launching of *Sputnik I.* Professor George Pokrovsky predicts "Factories on Asteroids." Pointing out that meteorites pelting our planet "consist of iron with considerable admixtures of platinum, osmium, iridium, cobalt, and nickel," the Soviet scientist suggests that such riches appear to be particularly abundant in the asteroid belt between Mars and Jupiter. "I am convinced," he writes, "that in time this belt will be the Urals of interplanetary space. In that area there will be established mines, plants, machine-shops and settlements serving rocket transport within the solar system."

Outer space is nothing but vacuum

which in time to come will be imported to earth "as a most valuable material" for man's instrument-building factories, the professor predicts, since production of vacuum on earth is so difficult and expensive. He says it is also possible that, along with rare-metal facturies on asteroids, man will erect his instrument factories in outer space to take advantage of cosmic vacuum on the spot.

Device Might Screen Out Stroke-Prone Astronauts

A radically new instrument whic measures blood pressure in the brai could be used to screen out potentia astronauts prone to strokes or t "blacking out," according to its inventor.

Dr. Melvin Thorner, who develope the Thorner Pulsensor with the Decke Corp., cited two space applications o the instrument. First, he said, the measurement of brain blood pressure coul be very important in the selection o astronauts. Patients with normal arm blood pressure have been found to hav high cerebral blood pressure—wher disease hits. There is no present clinica method to measure brain circulation.

Dr. Thorner also suggest that th pulsensor could be incorporated into ar automatic "anti-g" system to comba blacking out under g forces. When the instrument registers a drop in bloo circulation to the brain, the pilot's sea would automatically tip over into th approved couch position.

The pulsensor, which resembles a pair of goggles, works by putting ai pressure on the eye socket until the pulse stops. Systolic pressure is then read on a gauge. Dr. Thorner said the device could be modified to fit in a space helmet, with transparent panes to allow the pilot to carry out his duties.

Doctor Drinks Recycled Waste in Six-day Test

A U.S. Navy Medical Service Corps captain has completed with no ill effects a six-day test in which the only liquid he consumed was his recycled metabolic waste.

Results verify that there are no harmful effects from the continual use of recovered water. Captain Roland A. Bosee, USNMSC, received blood analyses, including white and red cell count, and urine analyses before, during and after the test period.

The General Electric device used for recovery and purification was developed in connection with a National Aeronautics and Space Administration contract. Capt. Bosee, director of the Air Crew Equipment Laboratory of the Naval Air Materiel Center, said the device may be used in human confinement tests at the Laboratory.

The Laboratory already has run a six-day test in which subjects breathed their own purified oxygen. Eventual plans call for the combination of both tests, simulating a 14-day trip by a crew of from two to six men with only limited quantities of water and air.

Chemical and organic tests showed that water produced by the device had fewer impurities than tap water.

mergers and expansions

PHILCO CORP. will occupy a new 5-million building at its Western Development Laboratories in Palo Alto, Calif., within a year. Over 2000 employees including space communications engineers, scientists, program managers, mathematicians, systems managers, designers and physicists will be employed in the 250,000-sq.-ft. building.

CLAUSER TECHNOLOGY CORP. has been formed near Los Angeles by former Space Technology Laboratory VP and director of research, Dr. Milton U. Clauser. The firm is located at Torrance for the time being, pending the establishment of permanent facilities. Assisting in the formation of the company was the San Francisco venture capital firm of Draper, Gaither & Anderson.

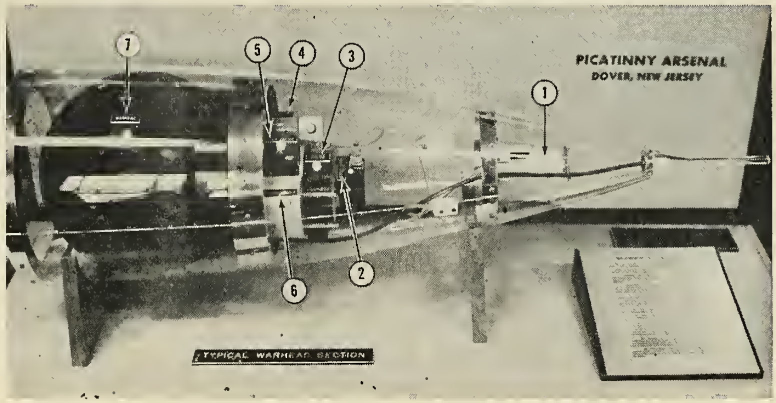
GABRIEL CO. has consolidated its Bohanon and Rocket Power/Talco divisions under the direction of Charles E. Bartley, president of Rocket Power/Talco. Combined operation of the consolidated divisions will be at the Rocket Power/Talco facility at Falcon Field, Mesa, Ariz.

DOUGLAS AIRCRAFT CO. is organizing a subsidiary corporation to conduct advanced research into exotic propulsion systems to power space vehicles. Donald W. Douglas Jr. and T. C. Lee, former manager of advanced research and rocket division of Aerojet-General, said that Astropower Inc. will be headed by Lee as president.

GENERAL ELECTRIC Defense Systems Department has established a Space Systems Operation in Santa Barbara, Calif. The new component will be managed by Benjamin G. Walker, formerly on the technical staff of the Department's technical Military Planning Operation in Santa Barbara.

INFRARED INDUSTRIES and Cramer Controls have reached a tentative merger agreement whereby Cramer would become a separate division of subsidiary of Infrared, retaining the same management. Plans call for Infrared to issue to its stockholders additional shares equal to 5% of its outstanding shares. Cramer stockholders would then receive two shares of common stock of Infrared for each share of Cramer common stock.

REFLECTONE ELECTRONICS INC. will complete the first of several plants on its 10-acre site near Fort Lauderdale within six months. The Connecticut-based company just completed the navigational trainer for the first *Polaris* submarine.



Army Shows off Warhead Design

TYPICAL WARHEAD designed by Army's Picatinny N.J., Arsenal, now on display at Princeton, shows (1) fuze, (2) pressure sensor, (3) safing device, (4) power supply, (5) timer, (6) control unit, and (7) warhead itself.

financial

Northrop Corp.—Fiscal-year earnings just released show profit of $7.7 million, an increase of 5.6% over the previous year. Sales amounted to $233.7 million, a decline of 12% from the $263 million from the previous year.

Consolidated Diesel Electric Corp.—Net sales of $24.9 million for the year ending July 31 is reported, a 19% jump over the previous year. Net income in the same period rose from $40,276 to $162,465.

Texas Instruments—Third-quarter earnings rose to $54 million from $47 million the same period a year ago. Net earnings were $3,596,000, compared with $3,572,000 a year ago.

American Bosch Arma—Sales for the first nine months amounted to $93.3 million, compared with $90.1 million for the same period in 1959. Consolidated net income dropped to $981,976, against $3 million for the same nine months in 1959.

Martin Co.—Sales rose to $164.3 million for the third quarter, compared to $129.5 million in the like period of 1959. Earnings increased to $4.5 million from $3.2 million in last year's period. Nine-months figures showed sales up 23.4% to $446.3 million and earnings 28.6% to $12.2 million.

Thiokol Chemical Corp.—Nine-months sales totaled $124.5 million with profits of $2.7 million. Sales approximated the same period last year, but net earnings fell 34% lower. Rocket Operations, which accounted for much of the loss, experienced a continuation of certain non-fee bearing contract overrun costs. Thiokol says problems causing these added costs are subsiding, Reduced sales by Chemical Operations to Rocket Operations caused a decrease of 21% in total sales of Chemical Operations.

Lockheed Aircraft Corp.—Net earnings for the three months ended Sept. 25 totaled $5.5 million, making it the most profitable quarter in nearly six years. Sales for the period were $305 million. A year ago Lockheed reported a loss of $2.8 million on sales of $324 million. Nine months totals show a loss of $49.9 million on sales of $962.3 million. The profitable quarter follows the write-off decision which gave the company a first-half loss. Backlog at the end of the third quarter stood at $1.4 billion, and Chairman Gross reports that the company already has recovered $27 million in tax carryback credits growing out of the heavy write-offs at midyear.

Chance Vought Aircraft—Sales dropped somewhat to $56.3 million during the three months ended Sept. 30 from $59.2 million the previous year. Net income of $1,191,944 was only slightly below last year's third-quarter earnings of $1,209,651. Sales for the first nine months were $169.8 million and net income was $2.8 million, compared with $191.7 million and $4.3 million in 1959.

Meteor Offers Open License Deal on Adaptable TV Drone

AN ITALIAN FIRM says it is willing to openly negotiate licensing agreements with foreign companies for the manufacture of its military drone—minus a few features such as electronic packages.

Meteor, S.p.A. feels it has a product which is adaptable to many battlefield tactics, and can meet most requirements, and thus can be unorthodox in marketing its radio-controlled television drone. The company says it is prepared to "grant its construction license to other foreign Armed Services suppliers." The surveillance drone is the *Meteor P.2,* one of two offerings by the firm—the other being a drone belonging to the more common target variety.

The TV version is 14 ft. 5 in. long, with a wingspan of 12 ft. 2 in. Its normal empty weight is roughly half the recommended maximum weight, 463 lbs. opposed to 930 lbs. With a payload area of .4 cubic yard, the drone has sufficient capacity to house a 243-lb. electronic assortment.

Standard equipment is a TV camera and a TV transmitter. The *Meteor P.2* is probably the only operational drone anywhere which is not intended for target practice. There is no boast of multimillion R&D; there is no need to give an average soldier training complicated by sophisticated scanners, recorders, developers or delayed transmissions. The *Meteor P.2,* simply enough, offers an instantaneous TV view of battle conditions to a field commander in an operating area from 60 to 100 miles through the proven, "old fashioned" television method.

Controlled from the ground and boosted during take-off by rockets or compressed gas, both drones feature fiberglass construction with blocks of expanded resin for buoyancy in water recoveries. All electronic packages are impervious to salt water.

Reports Says British Have Rocket-Armed Flying Auto

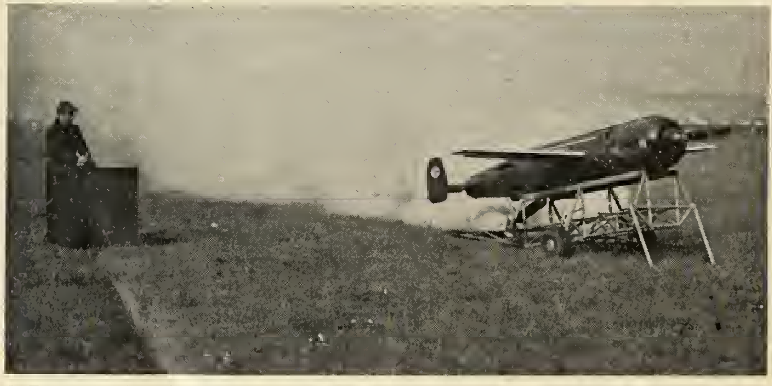
LONDON—The British Army may soon be equipped with a rocket-firing flying automobile, it is reported here.

A prototype is said to have been built at Coventry and given preliminary trials at the Army's Fighting Vehicles Research Establishment, Chobham, Surrey.

The design is reported to be a four-wheeled land vehicle capable of high speeds across country, but also able to fly for short distances. It is neither a hovercraft nor a true aircraft, these reports say, but relies on a new development of the jet engine for its lift. It would carry one or two men.

Preliminary trials are said to have been successful enough so that the Army has ordered the vehicle to be ready for full-scale flying trials before the end of the year. Seven firms—including two of the "Big Five" British automobile firms—reportedly are taking part in its development.

No details about the vehicle's rocket armament have been released. They might be 2-in. air-to-ground missiles.



METEOR P.2 "Ricognitore Televisivo Radioguidato" (TV Surveillance Drone) takes off at full RPM of 240-hp four-cylinder radial engine with rocket booster. The drone is under control of VHF 5 modulated tone carrier signal of ground transmitter.

Countdown for Survival

(Continued from page 16

being somewhat cynical, I feel that re tape and procedures are a fact of life. Yo can only minimize them, not eliminat them.

Your last questions on scientific objectives and decision-making are somewhat redundant. I think that one problen impeding our decision-making is the refusal of top government to face the fac that someone must run the space effor with a national goal in mind. The splintering of effort between DOD and NASA—with much of the space effort in DOD b subterfuge—is a serious block to any soli program.

George R. Arthur, President
American Astronautical Society
New York City

Must Decline to Comment

Thank you very much for sending me a copy of your open letter to Vice President Nixon and Senator Kennedy, and your nine-point proposal.

Since this open letter was directed to the presidential candidates, I do not feel that it would be appropriate for me to comment on your proposal.

Arleigh Burke
Chief of Naval Operations

I am appreciative of your invitation to comment on your nine-point proposal. However, after very careful consideration, I do not believe that it is appropriate for me to comment for publication on the proposal at this particular time. Of course, I do have my thoughts on the matter but I believe that the possible political implications might result in misinterpretation. I hope that you will understand my position in this matter.

Nonetheless, please accept my continued high regard for your fine magazine whose lucidity and complete coverage of the missile field is of such continuing great interest to those who are involved in the space age.

W. F. Raborn
Vice Admiral, USN
Director, Special Projects
Washington

I have been notified that current policy will not permit me to comment. The current position is that we in the Army must be very careful to keep ourselves disassociated from political activity, at this time in particular.

Wm. J. Ely
Brigadier General, GS
Director of Army Research

Thanks for calling my attention to your letter and its accompanying proposal. We'll certainly watch the project with interest. On the other hand, I fear it would be inappropriate for me to contribute to MISSILES AND ROCKETS' forum on the subject at this time.

C. V. Clifton
Brigadier General, GS
Deputy Chief of Information
U.S. Army

Thank you for the opportunity to comment on your open letter. I feel, however, that the comments in this area are best left to the candidates themselves. I will be most interested in seeing their response.

Earl Dallam Johnson
President
General Dynamics Corp.
New York City

I was quite interested in reading your open letter and proposal, and even more interested in the public reaction.

I am, unfortunately, not in a position to give you any official comment for reasons which you can well imagine.

Peter A. Castruccio
Aerospace Division
Aeronca Manufacturing Corp.
Baltimore

As you well know, we have a very definite interest in the views requested of the candidates on the various defense issues, but this can be misconstrued as a purely selfish interest—so we don't believe we should comment for publication. We do appreciate the opportunity, and are following this one with extreme interest.

W. E. Van Dyke
Corporate Director, Public Relations
North American Aviation, Inc.
Los Angeles

Rallies to Kennedy

Re M. L. Carlisle's letter in the Oct. 7 issue:

Regardless of the party creating the DOD, it has been sustained by the GOP dministration.

I gather from Sen. Kennedy's Proposal that a committee will "certainly tudy the feasibility and efficiency of" arious commands. It does not imply that e does not know of NORAD's existence.

Carlisle's first sentence in his second aragraph sounds like a more passive lend of McCarthyism.

Was Ike aware of the U-2 flights? elatedly, and in opposition to Mr. Nixon's stand on the absolute necessity of U-2 flights, I am venturing to say that the U-2 flights are not our primary intelligence-gathering instrument. Therefore, cancellation of such flights does not leave us void of data inputs.

Is an awareness of rare GOP achievements an acceptable criterion for selecting President? Merely speaking of "superb dvances" by the GOP is "Nixonerbage." erhaps Carlisle could list these one or wo advances.

Sen. Kennedy is to be commended for escribing his programs and listing his ounsel.

People of the technological community should be aware that the Democratic Congress has boosted the administration's appropriations for the DOD.

Henry P. Organ
Lockheed Missiles and Space Div.
Sunnyvale, Calif.

Maybe Not So 'Modest'

No one can deny the urgency of the issue of defense and space exploration. As you quite properly point out, these two subjects are really one inextricably intertwined issue. Moreover, this issue is one upon which the two candidates ought to make their views known, at least generally.

However, I must raise the question of time and preparation. Your proposals—I suspect that they are rather ironically called "modest"—are in fact complicated, provocative, and in some instances even revolutionary. Thus, have the two candidates the time—the cloistered time—the information—the secret information—and the staff—the trained staff—adequate to deal with proposals which are heavily freighted with profound consequences?

Mansfield D. Sprague, Vice President
Public and Industrial Relations
American Machine & Foundry Co.
New York City

Voices from the Past

(Editor's Note: The following letter was written prior to Mr. Nixon's reply to M/R's open letter.)

In your Oct. 24 issue, you state that "there is no obtainable record that he (Nixon) has said anything at all on space exploration or its part in national defense."

On Oct. 5, 1957, according to news reports, Mr. Nixon described *Sputnik I* as "a stunt, with no military or scientific value." On Oct. 15, 1957, it is alleged, he changed the statement to: "It would be incorrect to say that (the *Sputnik*) is a stunt, with no military or scientific value."

I appreciate very much your open letter to the candidates, and your reporting on the candidates' replies (or lack thereof). It would be interesting to get the results of a survey among engineers and scientists as to their opinion of who is ahead in the missile-defense-scientific race. Wasn't it President Eisenhower who said that we aren't in a race (besides, we are ahead, and also, we are gaining, so that we will catch up soon)?

It is interesting to note that Senator Saltonstall, our "senior" Senator, refuses to debate with his opponent, Mayor O'Connor. It was Saltonstall who said, in early 1956, "We have a stockpile of ICBM's." In 1957, he opposed statehood for Alaska on the grounds that "it would not be in the best interests of the defense of the United States." Senator Saltonstall also has been an advocate of, and author of bills for, "negotiated" defense contracts, as compared to competitive bidding. It would be interesting to poll the readers of M/R and determine their collective opinion on how much defense costs

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Working with optics, mechanics and electronics, the Kollmorgen Optical Corporation designs and manufactures many different types of remote viewing, inspection and testing instruments and systems. For a new illustrated brochure write Dept. 10-N.

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could be cut (with safety) and how much procurement would actually be speeded up if competitive bidding were used wherever possible.

Please keep up the good work. Obviously our founding fathers knew what they were doing when they provided for a free and independent press.

N. A. Denman, Mgr.
Basic and Experimental Physics
Engineering Services
Falmouth, Mass.

Suggestions and Goals

I am pursuing with great interest the course of debate as delineated in your proposal concerning the national path and philosophy vis-à-vis our position on defense and on our position in space exploration. I would leave, for myself, the issue of defense to the generals and admirals who, indeed, are the qualified authorities in this field. However, when we turn to the topic of space exploration and such matters as the space race with the USSR, I should like to comment.

I see much skipping about in your program and some very optimistic dates for certain accomplishments. Moreover, the omissions in your "program" for space exploration are serious and, indeed, stop short of certain major goals.

There has been great timidity in firmly specifying to the citizenry of the United States the particular goals in space, the steps by which we realize these goals, and the critical item of attaching a timetable to both the goals as specified and the steps that are necessary prerequisites to such attainment. Most persons are also deluded when they attempt to point out the authorities responsible for our failures to accomplish various space missions.

It is not our scientists, engineers and sundry program managers, but Congress whose whims regarding funding alternately starve projects or stuff them to the point of regurgitation. You cannot legislate engineers and scientists to make discoveries. They can be aided by long-time (5-10 years) funded programs for research and development backed up in turn by allowing 1% of the Gross National Product for *basic* research in *all* of the sciences.

Supporting this in turn by competitive bidding from industry for various programs and severely limit the CPFF type of contract and then the U.S. will get some results.

Oh, yes—the goals! They are three:

(1) a manned, long-lived space station;
(2) man on the moon followed by a lunar base;
(3) manned trips to, and landing on, the planets Mars and Venus.

The steps by which we accomplish this are delineated and ordered on the accompanying chart. The timetable? It could all be done by 1975, but only Congress can really put a timetable on our activity and on the items noted.

Saunders B. Kramer
Sunnyvale, Calif.

We regret that space limitations prevent reproduction of Mr. Kramer's thoughful and interesting chart.—Ed.

Arms No Guarantee

Your open letter and Oct. 3 editorial both reflect what I believe is incorrect thinking. Your premise appears to be that in order to survive we must literally pour armament, both offensive and defensive, into what is called space. You make the point that declaring space to be "off limits" to the military will prevent us from attaining the regulation and security we now have from the "freedom of the seas" concept.

My contention is that there is no regulation of the seas and therefore no security is afforded by the seas. Actually we are extremely insecure because of the dangerous possibility (or even probability) of missile-firing submarines lurking close to our shores. Such a weapon system is capable of bombarding our country with even less warning than the present generation of ICBM's. Then is not this dangerous situation in the seas analogous to that which we would have if weapon systems were constantly over our heads in space? This is not security. This is putting our heads in a lion's mouth knowing that after a time the lion's jaws will ache so much that he must close his mouth!

Has an armament race ever ended in peace? And of the next war, will there be a victory? It is better to have Khrushchev (or even Mao Tse-Tung) pounding a desk at the United Nations, or is it better for Khrushchev or Mao Tse-Tung to pound the starting button for the next war? Strict regulation with limitation and inspection is the *only* way to survival.

R. E. Margolies
Los Angeles

contracts

AIR FORCE

$41,000,000—**American Bosch Arma Corp.**, for *Atlas* all-inertial guidance systems and ground support equipment.

$7-8,000,000—**Aetron**, Azusa, Calif., for architect-engineering services.

$1,100,000—**North American Aviation, Rocketdyne Div.**, McGregor, Tex., for producing boosters for the *Regulus* high-speed target drones.

$500,000—**Curtiss-Wright Corp., Research Div.**, Quehanna, Pa., for research, development and production of beryllium oxide ceramic components for nuclear reactors.

$500,000—**Westinghouse Electric Corp.**, Blairsville, Pa., for precision-finished castings of Hipernik for the *Falcon* missile.

$310,000—**Blaw-Knox Equipment Div., Blaw-Knox Co.**, Pittsburgh, for development and fabrication of 85-ft.-diameter solar radio telescope antenna.

$250,000—**Traid Corp.**, Encino, Calif., for airborne high-speed cameras to be used on Lockheed QF-104 drone aircraft.

$151,774—**Blackinton & Decker, Inc.**, Denver, for AFAFC ADPS Complex (Construction of Automatic Data Processing System Facilities) Air Force Accounting and Finance Center.

$128,415—**Raytheon Co.**, Waltham, for tube, klystron.

$100,000—**Pan American World Airways**, for 16 mm high-speed cameras to be used in photo instrumentation at Cape Canaveral.

$98,934—**The Marquardt Corp.**, Van Nuys, Calif., for hardware for in House High Energy Storable Test Program (*Joshua*).

$91,335—**Rocketdyne Div., North American Aviation Inc.**, Canoga Park, Calif., for rocket engine flame investigation.

NAVY

$20,000,000—**Northern Ordnance Inc.**, Minneapolis, for additional production of Mk 10 *Terrier* guided missile launching systems.

$1,500,000—**International Telephone & Telegraph Corp.**, Fort Wayne, Ind., for manufacturing of fuzing mechanisms for the *Terrier* missile.

$600,000—**Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.**, Wyandanch, L.I., N.Y., for development of two long-range radars for tracking satellites or space capsules from Navy instrumentation ships.

$166,210—**ITT Laboratories, Div. of International Telephone and Telegraph Corp.**, Fort Wayne, Ind., for developing, fabricating and furnishing two Doppler Receiving systems.

NASA

$6,584,624—**North American Aviation, Rocketdyne Div.**, Canoga Park, Calif., for design of a model engine known as H-1 for use as a new powerplant in missiles. Work to be done in Calif. and at Cape Canaveral.

$6,000,000—**Astronautics Div., Chance Vought**, Dallas, for final assembly and launching of the *Scout* rocket.

$67,849—**Aerojet-General Corp.**, Azusa, Calif., for development and fabrication of an optical system for *Aerobee* Zero Gravity project, to be delivered to Lewis Research Center, Cleveland.

$40,355—**Veeco Vacuum Corp.**, New Hyde Park, L.I., N.Y., for helium mass spectrometer type leak detector, for Lewis Research Center, Cleveland.

$26,408—**National Light Metals and Plastic Co.**, Caro, Mich., for services and materials for manufacturing 28 Fin assemblies.

ARMY

$4,673,699—**Raytheon Co.**, Waltham, Mass., for 9 battery sets and 5 sets of field maintenance equipment.

$4,019,265—**Raytheon Co.**, Waltham, for 234 NATO-*Hawk* missile components and subassemblies.

$3,267,396—**Raytheon Co.**, Waltham, for engineering services for *Hawk* missile system.

$2,973,976—**Raytheon Co.**, Waltham, for additional engineering services to be performed on the *Hawk* missile system.

$2,334,664—**Pearce and Gresham**, Decatur, Ala., two Contracts—(1)—$1,817,153 for missile assembly shop and (2)—$517,511 for missile assembly hangar.

$1,554,012—**Chrysler Corp.**, Detroit, for additional funding for the *Jupiter* missile system.

$761,081—**Raytheon Co.**, Waltham, for 27 *Hawk* missiles, 6 guidance and control packages.

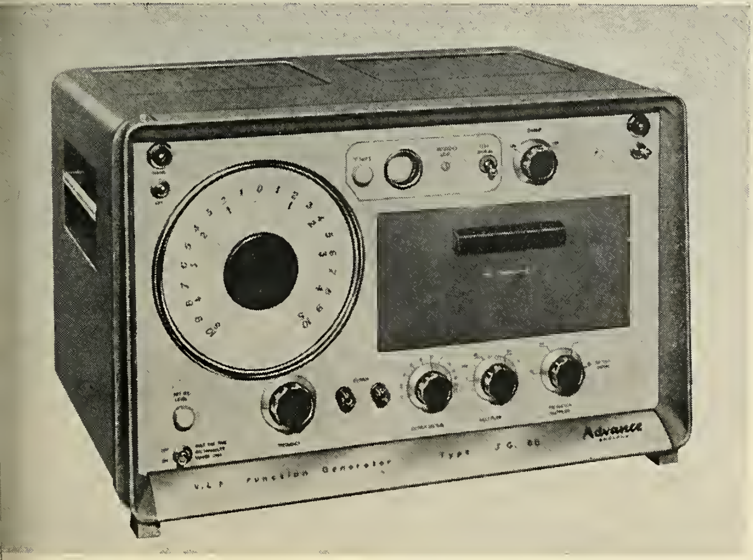
$694,000—**Fruin-Colnon Contracting Co.**, Burlingame, Calif., for guided missile assembly, technical supply facilities and Edison St., Extension, Beale AFB, Calif.

$462,048—**Raytheon Co.**, Waltham, for *Hawk* missile system replenishment repair parts.

$99,683—**LaQua Construction Co.**, Lawton, Okla., for re-entry vehicle facilities, Altus AFB, Altus, Okla.

$71,985—**Raytheon Co.**, Waltham, for concurrent repair parts, *Hawk* missile system.

$37,000—**U.S. Steel Corp., Consolidated Western Steel Div.**, Los Angeles, for rocket motors.



enerator Produces Any Wave Form

A function generator that provides ny waveform at repetition rates down) one cycle every 200 seconds is avail- ble from General Measurements Com- any, Inc.

Called the SG88 V.L.F. Function enerator, it combines accuracy with eat flexibility of operation and is esigned to fill a gap in the range of boratory instruments currently avail- ble. It is presented as a tool for solu- on of many simulation and computer design problems, for servo-system analysis, vibration testing and numerous similar applications.

The SG88 is also invaluable for practical analysis, performance testing and simulation problems on a variety of electronic, electric, electro-mechanical seismographic and medical equipment. It eliminates the need for specially shaped and wound potentiometers and complex electronic waveshaping circuits.

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etal-Ceramic Terminals

The L-series line of standard sized gh voltage metalized ceramic term- als, with ratings as high as 15,000 lts, and which meet JAN 1-8 and N 1-10 specifications is available om Metalizing Industries, Inc. The series terminals consist of a glazed ramic body, metalized to permit easy ldering into the assembly, and with cessary hardware to allow termina- on of the lead. The coating will with- and 450°F for 1½ minutes.

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emiconductor Probe

A Thermoelectric Probe, Model E-1, is available from Electro Impulse boratory, Inc. The probe is suitable f type testing of semiconductors and tals, detection of P-N junctions in niconductors and the measurement relative thermoelectric power of semiconductors and all metals. It consists of a sensitive galvanometer, a cold base, a hot point and a variable DC attenuator. The base can be removed and an additional cold point can be added.

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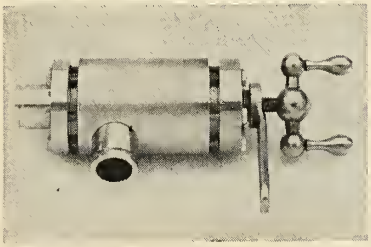
Ultra High Vacuum Valve

Anultra high vacuum valve, said to achieve better than 10^{-9} mm Hg. in the temperature ranges from −200° to +600°C is available from Vactite Co.



The all metal valve, including a copper seal, is designed for applications in space chambers, vacuum tube processing, particle accelerators, and other types of high vacuum systems. The valve is available in sizes from 0.5 to 4 in. I.D. and is reliable for more than 100 seals per gasket.

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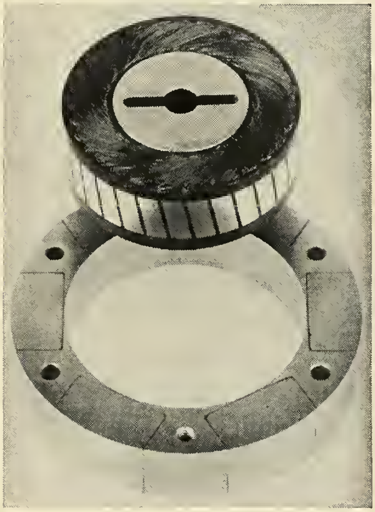
DC Torque Motors

A line of low-speed, high-torque, dc torque motors for use as high-performance torquers or direct-drive servo motors is being marketed by Giannini Controls Corp. The pancake-type, multi-pole, permanent-magnet torque motors feature ultra low levels of friction and ripple torque and extremely high values of torque per watt and torque/inertia. Additional advantages include linear input current vs. torque output and the elimination of backlash problems when used in direct-drive servo applications.



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Digital Comparator

A voltage comparator that operates as a high-low limit alarm over a wide input range is available from KIN TEL Division of Cohu Electronics.

The instrument, the KIN TEL model 465 Voltage Comparator, indicates whether an applied input voltage is over, between, or below preset tolerance limits. Its wide range, from ±0.0001 to ±1000.0 volts makes it applicable to many of the "go-no-go" type problems encountered in military and industrial systems.

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Horizontal Motion Isolator

A horizontal-force mount, Series RM, designed for isolation of shock and vibration produced by machinery whose operation develops predominantly horizontal forces, is available from Barry Controls. Each mount will handle up to 4000 pounds static load.

The Series RM Horizontal-force Mount is 10-5/16 in. by 8 in. overall and 1-3/8 in. high. An attachment bolt and locknut are furnished with each mount. The RM Mount eliminates the need for special foundations or inertia blocks.

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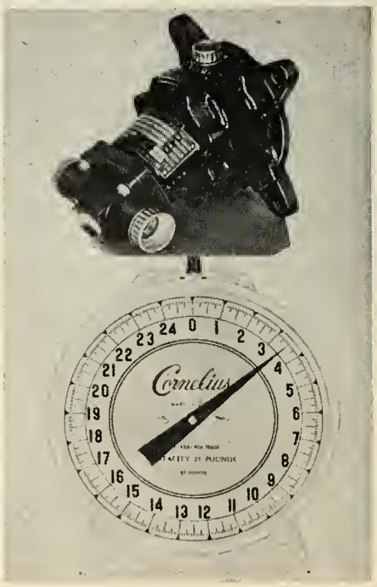
Low-Friction Motors

Hydraulic motors and fixed displacement pumps with completely new design features are being manufactured by The Cornelius Co. Both the motors (63000 Series) and the pumps (61000 Series) are rated for 3000 psi. system pressures.



Advantages of the hydraulic units are 96 to 98% volumetric efficiency, 92 to 93% overall efficiency, low operating cost, rapid response and proven performance. Inlet and outlet parts can be tailored to specific requirements.

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Small Pressure Transducer

A micro-miniature, flush diaphragm Absolute Pressure Transducer, will be produced by Statham Instruments, Inc. The pressure transducer is "smaller than a dime" and was designed for airborne, missile and wind tunnel applications where small size and light weight are critical. The micro-miniature transducer features a flush diaphragm with high frequency response; ranges are 0-10 psia to 0-100 psia; and size is 0.590 inches diameter by 0.050 inches thick.

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Ballistic Delay Initiator

A ballistic delay initiator is available from Chromalloy Corp.'s Propellex Chemical Division.

Fired by a gas pressure input of 400 to 500 psig, this 1.5-oz. unit generates a pressure of 2000 psig in a closed volume of 0.3 cu. in., after a delay of 0.5 second.

The special .38 caliber cartridge used in the device can be modified for various delays and/or pressure outputs, to suit a particular application.

Circle No. 234 on Subscriber Service Card.

3000 PSI Selector Valve

A miniature 3000 psi selector valve for directional flow is available from Republic Manufacturing Co.

Seals are wear-compensating, wiping the surfaces clean as they move across the ports. Line pressure aids sealing. Handle turning is easy, even at maximum pressure. Maximum panel thickness is 5/16 in. Body is forged aluminum alloy, with internal parts stainless steel.

Circle No. 235 on Subscriber Service Card.

Magnetic Relay Amplifier

Lumen Inc. has announced an addition to its line of bi-stable magnetic relay amplifiers. Model 1211 has as its input a photo-resistor with a varying resistance of 2 to 5 megohms. It functions at extremely low levels of current, reacting to signals of 10 to 25 microamps. Its output is in the nature of 10 volts at 10 mills; hence it can drive a heavy duty relay coil with far greater sensitivity than was previously feasible.

Circle No. 236 on Subscriber Service Card.

Magnesium Oxide Whiskers

Semi-Elements, Inc. has available Whiskers of Magnesium Oxide that range from 3 to 4 mm in length and from 1 to 5 mils in cross section. The research phase of the program on the semiconductor Magnesium Oxide is at a point where magnesium oxide has been doped with more than 20 different impurities.

Circle No. 237 on Subscriber Service Card.

Varactor Diodes

Two series of microminiature silicon mesa diodes, 1/8 in. in length and width, have been developed by Sylvania Electric Products Inc.

Known as microminiature "varactors" or amplifying diodes, the new microwave components (Series D-4140A to E and D-4141A to E) are hermetically sealed in Sylvania-designed cylindrical glass cases, making them especially useful in printed-circuit cavity and strip transmission lines.

Circle No. 238 on Subscriber Service Card.

Three-Inch DC Blower

VAX-3-BD vaneaxial blowers, operating from direct current to produce an optimum output of 90 cfm. at 1 in. H_2O back pressure are available from Globe Industries, Inc. At 28 v.d.c. maximum current is 1.7 amps at free air delivery and motor windings may be provided for 4 to 115 v.d.c. operation. Life exceeds 500 hours.

Circle No. 239 on Subscriber Service Card.

X-Seal Good to 1200°F

Wiggins Connectors has available an all metal seal called "Bar-X-," which withstands temperatures from –450°F to 1200°F and peak pressures of 40,000 si. Wiggins reports that in a typical static seal application, the seal had ero leakage from room temperature to 1000°F with dry nitrogen at 1000 si.

Circle No. 240 on Subscriber Service Card.

Strain Gage Calibration

A Strain Gage Calibration Unit roviding a means of determining the age factor of an electric resistance train gage, resistance vs temperature curve, and creep behavior of the mounted gage is available from Cryogenic Research Co. Gages are subjected to strains (± 750 microstrain) within ± 0.3% of those calculated by displacement of a constant strength cantilever beam with a stepped block. Operating range; –452°F to +500°F.

Circle No. 241 on Subscriber Service Card.

Solenoid Valve Line

Cooler and quieter operation are features of 2 and 3-way solenoid valves manufactured by Allied Control Company, Inc. Valves can be supplied in normally open, or normally closed types, ¼ in. or 1/8 in. pipe sizes, A-C or D-C, conduit or grommet housings. Time delay, metering (bottom, 45°, side or pipe connector), free venting, and 3-way directional valves also available.

Circle No. 242 on Subscriber Service Card.

new literature

AEC ENGINEERING MATERIALS —Cooper-Trent Blueprint & Microfilm Corp., 2701 Wilson Blvd., Arlington 1, Va., has been contracted by the AEC to supply full-size blueline prints of CAPE-numbered materials or specific drawings announced in the Engineering Materials List, TID-4100 and Supplements. Queries regarding materials not in this list should be directed to AEC-OTI, P. O. Box 62, Oak Ridge, Tenn.

Circle No. 200 on Subscriber Service Card.

STRAIN GAGE SET-UP—Bulletin 360, released by the Strainsert Co., a division of Polyphase Instrument Co., describes the Model HW-1 Portable Strain Indicator. Included is a unique circuit design by which the new PIC indicator eliminates the time consuming operations normally involved in phase balancing to compensate for distributed capacity in lead wires.

Circle No. 201 on Subscriber Service Card.

MACHINE TOOL CONSTRUCTION —Information on "Building Block" design, standardized components and machine classifications is contained in a brochure from LaSalle Machine Tool Co. Descriptions and graphic illustrations are portrayed in an easily understandable manner. Also shown is a side, back and full view of a completed machine which was constructed of "Building Blocks".

Circle No. 202 on Subscriber Service Card.

TUNNEL DIODE KIT—The power of determining the purchase price while writing the specifications is available to tunnel diode users from Sperry Semiconductor Division, Sperry Rand Corp. Based upon a price and specification graph, the electronic engineer may chart an almost infinite variety of parameter combinations and simultaneously determine the various selling prices which apply to these combinations. The engineer may select the parameters he desires in a tunnel diode by marking them along the curves. Then by use of a formula he determines the selling price of the unit in quantities from 1 to 99.

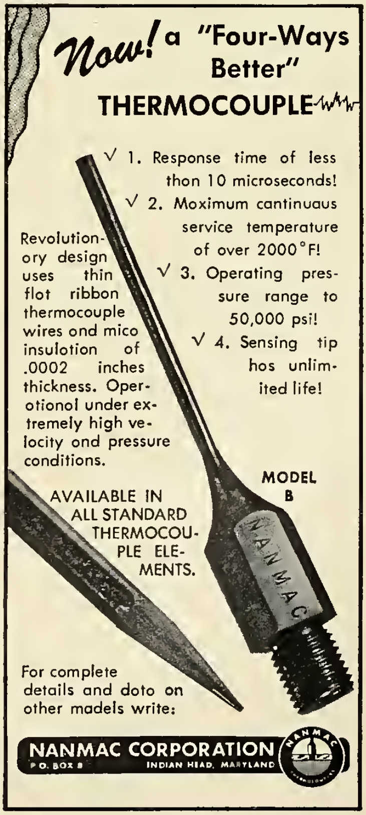
Circle No. 203 on Subscriber Service Card.

SLIDE MECHANISMS — A 16-page catalog from Jonathan Manufacturing Co., contains dimensional information, mounting patterns and descriptive information on ball-bearing slide mechanisms for electronic equipment cabinet chasis mounting. The Type II shock blocks, used to prevent damaging magnification of shock or vibration to slide-mounted electronic chassis and slide mechanisms are also described.

Circle No. 204 on Subscriber Service Card.

HIGH Q COIL—United Transformer Corp. has published their 1960-61 16-page supplement catalog. It offers complete information on electric wave filters and high Q coils. An easy reference Reactance-Frequency chart is also included. Further information is also given about UTC's other products.

Circle No. 205 on Subscriber Service Card.



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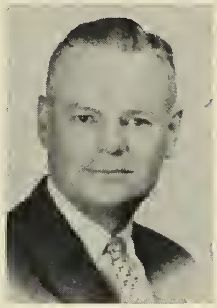

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Edward T. Connor: Promoted to vice president, marketing, for Instrument Development Laboratories, Inc. Prior to joining the firm in 1959 as manager, new product planning, he spent 10 years with General Electric Co. specializing in marketing and sales management.

Marvin J. Bock: Named chief engineer of the Kearfott Division of General Precision, Inc. Prior to joining the firm he was associated with Raytheon, where he completed developmental work on the AN/SP-12 system, *Lark, Sparrow III* and *Hawk I* missiles.

Carl F. Schunemann: Named to head the newly-established electronic products department of The Martin Co.-Baltimore. Prior to joining Martin, he served as chief engineer for Thompson Ramo Wooldridge Electronics.

David P. Ebaugh: Appointed chief of the Industrial Engineering Department, Automation Product Division of Nytronics, Inc. This division was formerly known as Sutton Electronic Co.

Maurice L. Smith: Named manager, advertising and sales promotion Metallurgical Products Dept., General Electric Co. Was formerly specialist-product planning and market research.

Dr. Arthur O. McCoubrey and **Dr. Joseph H. Holloway:** Named manager of research and manager, resonance physics research, respectively for Bomarc Laboratories, Inc.

Dominic L. Testa: Named advertising manager of Baldwin-Lima-Hamilton Corp.'s Industrial Equipment Division. Was formerly technical publications supervisor of the firm's Loewy-Hydropress Div.

Dr. Myer Geller: Joins the technical staff of Electro-Optical Systems, Inc., as senior scientist in the Solid State Division, where he will be responsible for materials research and spectroscopy in the field of stimulated emission optical devices. Was formerly affiliated with Hughes Products Semiconductor Division.

Col. Hohn H. Kerkering: Assumes the duties of director of the U.S. Army Engineer Research and Development Laboratories, succeeding **Col. H. J. Skidmore.**

Robert W. Jorgensen: Joins The Hallicrafters Co. as manager of market development. He previously served as management consultant with Booz, Allen & Hamilton, and vice-president, marketing, at The Richardson Co.

Robert Young: Joins Budd Electronics Inc. as president and general manager. Was formerly assistant general manager of the Electronics Division of A.C.F. Industries.

Edward R. Davis: Elected vice president, director of marketing and contract at Hydraulic Research and Manufacturing Co., a Bell Aerospace subsidiary. Was formerly West Coast marketing manager for Chance Vought Aircraft and western manager for Avien, Inc.

Harold P. Weinberg: Appointed chief materials engineer for Value Engineering Co. of Alexandria, Va. Was formerly head of materials engineering at the U.S. Naval Weapons Plant.

Dr. Kenneth M. Merz: Joins International Resistance Co., as manager of ceramic research. Was formerly engaged in ceramic research for the Cornell Aeronautical Laboratory; prior to that, was associated with Carborundum Co. and the National Lead Co.

Peter Pao, Robert Taylor and **Vincent Andreano:** Join Communication Electronics, Inc. as senior project engineer, head of the transformer development department and senior design draftsman, respectively. All were formerly with Nems-Clarke Co., a Division of Vitro Corp. of America.

Harold E. Kren: Named manager of the recently formed Monterey Laboratory of Boston-based Laboratory For Electronics, Inc. Was previously manager, Administration and Sales, for Technical Operations, Inc.

Warren Shepard: Elected national ma
keting manager for shaft encoders for Li
ton Systems Inc. Formerly served a
project coordinator for the shaft encode
and as national sales manager.

Dr. Juls Miller: Appointed head o
Schaevitz Engineering's new Electromag
netic Devices Dept.

Dr. Robert C. Brumfield: Named dire
tor of engineering for MHD Researc
Inc. Prior to joining the firm he was d
rector of operations research for the Wes
ern Div. of Operations Research, Inc.

George D. Howland: Appointed co
tract manager for the aerospace group
the Hughes Aircraft Co., replacing **Wi
liam Van Allen,** new materiel manag
for the company's manufacturing divisio
in El Segundo.

Robert G. Gallaghar: Joins the N
clear Science and Engineering Corp.
assistant manager of the Biology an
Medicine Dept.

Elmer F. Hinner and **John M. Marti**
Elected vice presidents of Hercules Pov
der Co. Hinner has been general manag
of the company's Cellulose Products Dep
since 1954 and a member of the Board
Directors since 1952. Martin has bee
manager of Hercules' Explosives Dep
and a member of the Board of Directo
since 1953.

Roy W. Pyburn: Appointed assista
to the president of Data-Control System
Inc. Was previously senior product pla
ning engineer for Ampex Corp.

Richard E. Love: Appointed marketi
manager of The Budd Company's Instr
ments Division. Was formerly with West
Instruments Division of Daystrom, Inc.,
industrial market manager.

Fred Lucas: Named sales manager
the new Magnetic Tape Division of Sark
Tarzian, Inc., Bloomington, Ind. Previous
served for seven years as assistant sal
manager, Semiconductor Div.

when and where

NOVEMBER

Government Contracting Course, National Defense Education Institute, sponsored by National Security Industrial Association and Harbridge House, Inc., Dayton, Nov. 7-18.

American Material Handling Society, meeting in conjunction with Material Handling Institute's Central States Show, Kentucky Fair and Exposition Center, Louisville, Nov. 8-10.

First National Die Casting Exposition and Congress, Society of Die Casting Engineers, Detroit Artillery Armory, Detroit, Nov. 8-11.

Institute of Radio Engineers, Mid-America Electronics Convention, (MAECON), Hotel Muehlebach, Kansas City, Mo., Nov. 14-16.

Sixth Annual Conference on Magnetism and Magnetic Materials, American Institute of Electrical Engineers, American Institute of Physics, Office of Naval Research, Institute of Radio Engineers, American Institute of Mechanical Engineers, Hotel New Yorker, New York City, Nov. 14-17.

IRE Professional Group on Production Techniques, Fourth Annual Conference, Boston, Nov. 15.

29th Symposium on Shock, Vibration and Associated Environments, U.S. Naval Supply Center, Oakland, Nov. 15.

Engineering Applications of Probability and Random Function Theory, Purdue University, Lafayette, Ind., Nov. 15-16.

Air Force, Navy and Industry Propulsion Systems Lubricants Conference, (unclassified), co-sponsored by ARDC's Wright Air Development Division and Southwest Research Institute, Hilton Hotel, San Antonio, Nov. 15-17.

British Interplanetary Society, One-day Joint Symposium on Space Navigation, Co-sponsored by Institute of Navigation, Royal Geographical Society Lecture Hall, London, Nov. 18.

Conference on Electro-Optical and Radiation Devices, Sponsored by IRE Professional Group on Electron Devices and American Institute of Electrical Engineers, Stanford Research Institute, Menlo Park, Calif., Nov. 20-21.

American Physical Society, University of Chicago, Nov. 25-26.

American Society of Mechanical Engineers, Annual Winter Meeting, Statler Hilton, New York City, Nov. 27-Dec.2.

Government Contracting Course, National Defense Education Institute, sponsored by NSIA and Harbridge House, Los Angeles, Nov. 28-Dec. 9.

DECEMBER

RE Professional Group on Vehicular Communications, Sheraton Hotel, Philadelphia, Dec. 1-2.

American Institute of Chemical Engineers, Statler Hotel, Washington, D.C., Dec. 4-7.

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Since MISSILES AND ROCKETS MAGAZINE first started giving a bimonthly report on the status of space vehicles and missiles and rockets, numerous readers have asked about the availability of reprints. The following charges are established:

1 to 100 copies—20¢ each;
100 to 500 copies—15¢ each;
500 or more copies—10¢ each.

Requests for reprints should be addressed to:

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Missiles and Rockets Magazine,
1001 Vermont Avenue, N.W.,
Washington 5, D.C.

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Samos—and What Happens Then?

ONE OF THE GRAVEST problems facing this Administration in its waning days, and one which will certainly carry over to the next Administration, is how to handle the *Samos* situation.

Samos is a reconnaissance satellite, a spy in the sky. It will eject or transmit photographs of terrain and occupants with incredibly fine detail. An Air Force project, the first *Samos* launching failed last month because of mechanical difficulty. The second is due before the end of the year.

The Soviet government certainly knows what *Samos* is, what it does and why it is there (to collect reconnaissance photographs). No secret has been made of this, although the exact composition of *Samos* payloads is and probably will continue to be closely guarded.

What will the Russian reaction be? A great number of people in this administration and a great number who hope to be in the next wish they knew the answer.

The conduct of the *Samos* program and its legal or illegal status lie within the great mass of unsolved questions concerning space and space law as an extension of international law.

What precedents are there to go by? There are many, and largely they involve ancient precepts of the freedom of the seas, freedom of air and the rights of any nation to self-protection and self-defense.

Putting first things first, as did Dr. John Cobb Cooper at the 11th International Astronautical Congress at Stockholm in August, we will attempt a definition. Dr. Cooper, an American, Professor Emeritus of International Air Law at McGill University and resident of Princeton, N.J., put it thus:

"Outer space, for the purposes of this convention, is defined as the area whose upper or outer boundary is the outer limits of the solar system, and whose lower or inner boundary is the lowest altitude above the earth's surface at which an artificial satellite may be put in orbit around the earth."

Then, attempting a corollary, we might take what Dr. Cooper calls the greatest definition of freedom of the seas ever expounded—that of Mr. Justice Storey in 1826:

"Upon the ocean, then, in time of peace, all possess an entire equality. It is the common highway of all, appropriated to the use of all; and no one can vindicate to himself a superior prerogative there. Every ship sails there with the unquestionable right of pursuing her own lawful business without interruption; but whatever may be that business, *she is bound to pursue it in such a manner as not to violate the rights of others."*

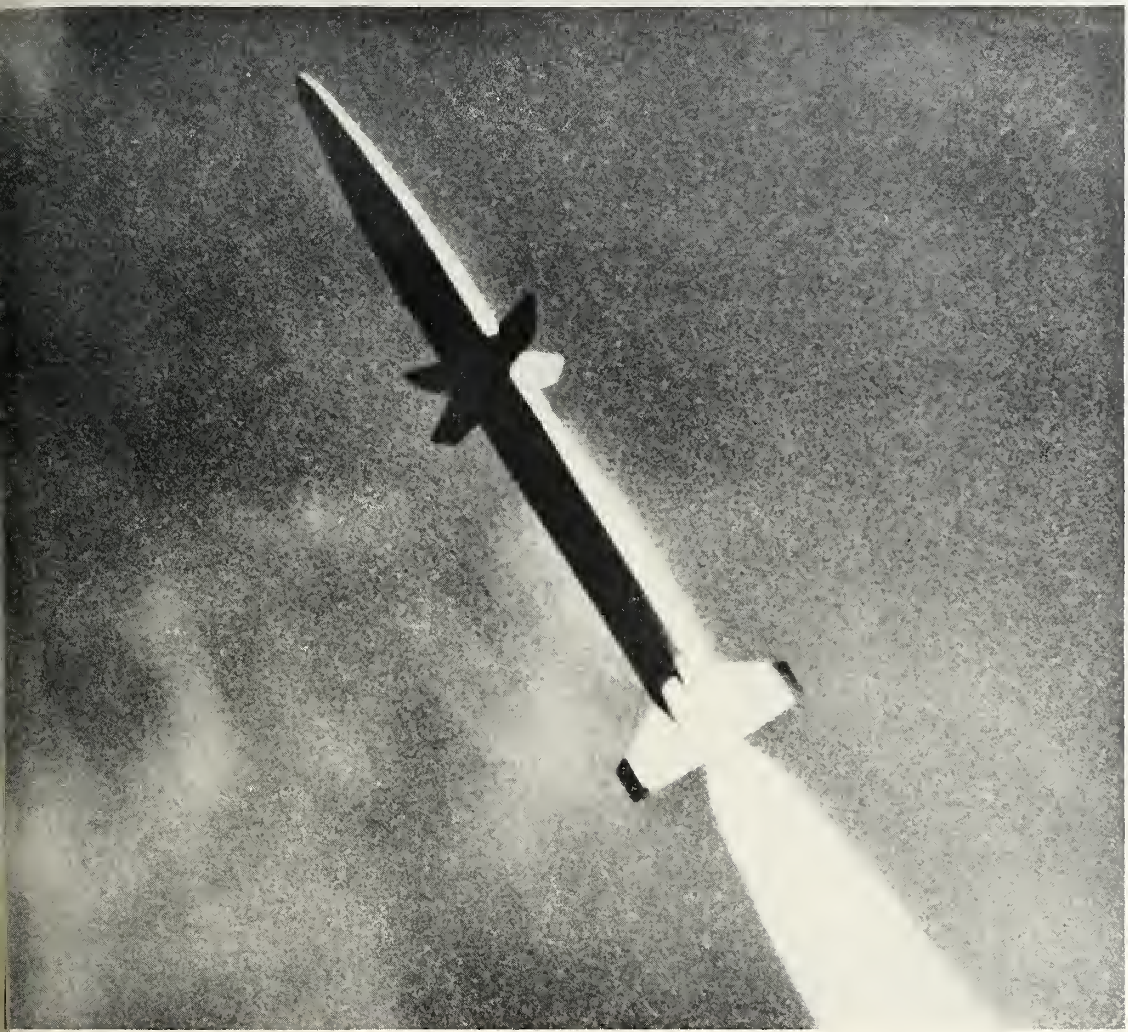
IT ALL SEEMS **SIMPLE—until** you come to that last sentence. Furthermore, several legal giants have had, in the past, strong words to say regarding the rights of states in the matters of self-protection. These include Chief Justice Marshall and Elihu Root, when he was President of the American Society of International Law.

The right of self-protection, said Mr. Root, "is a necessary corollary of independent sovereignty. It is well understood that the exercise of the right of self-protection may and frequently does extend in its effect beyond the limits of the territorial jurisdiction of the State exercising it." And later, it is "the right of every sovereign State to protect itself by preventing a condition of affairs in which it will be too late to protect itself."

That last sentence has a double hook. Is it the right of the United States, as this Administration has asserted, to protect itself from surprise attack by surreptitious reconnaissance? Or is it the right of another nation to protect itself from such reconnaissance?

We don't know. Neither do we know what Russia can and may do. This much we do know: *Samos* is about as provocative as any move we've made in our history. If we haven't a plan for every eventuality, diplomatic and military, we'd better back off and review matters.

Clarke Newlon



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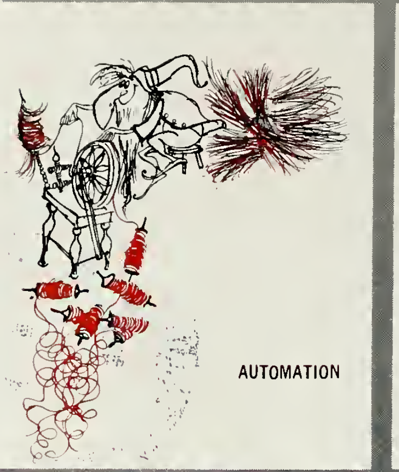

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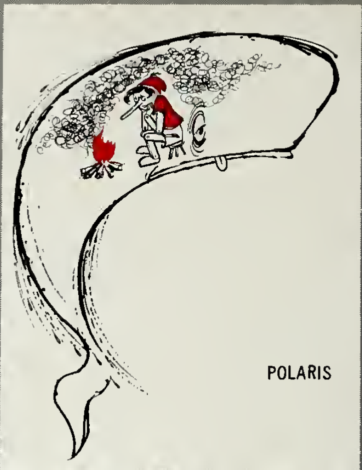

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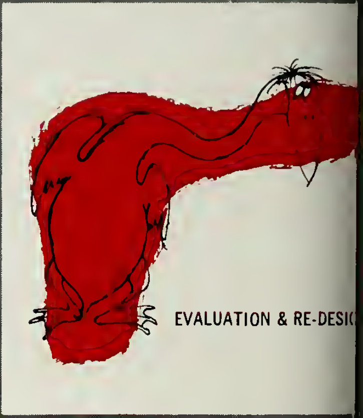

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Let us assure you, however, that our business is not with fairy tales. *It is the hardware of defense, space exploration and private industry.* All of our clients expect and receive realistic performance in engineering research and development. None of them desires to dilly-dally in the Land of Make Believe—*nor do we!*

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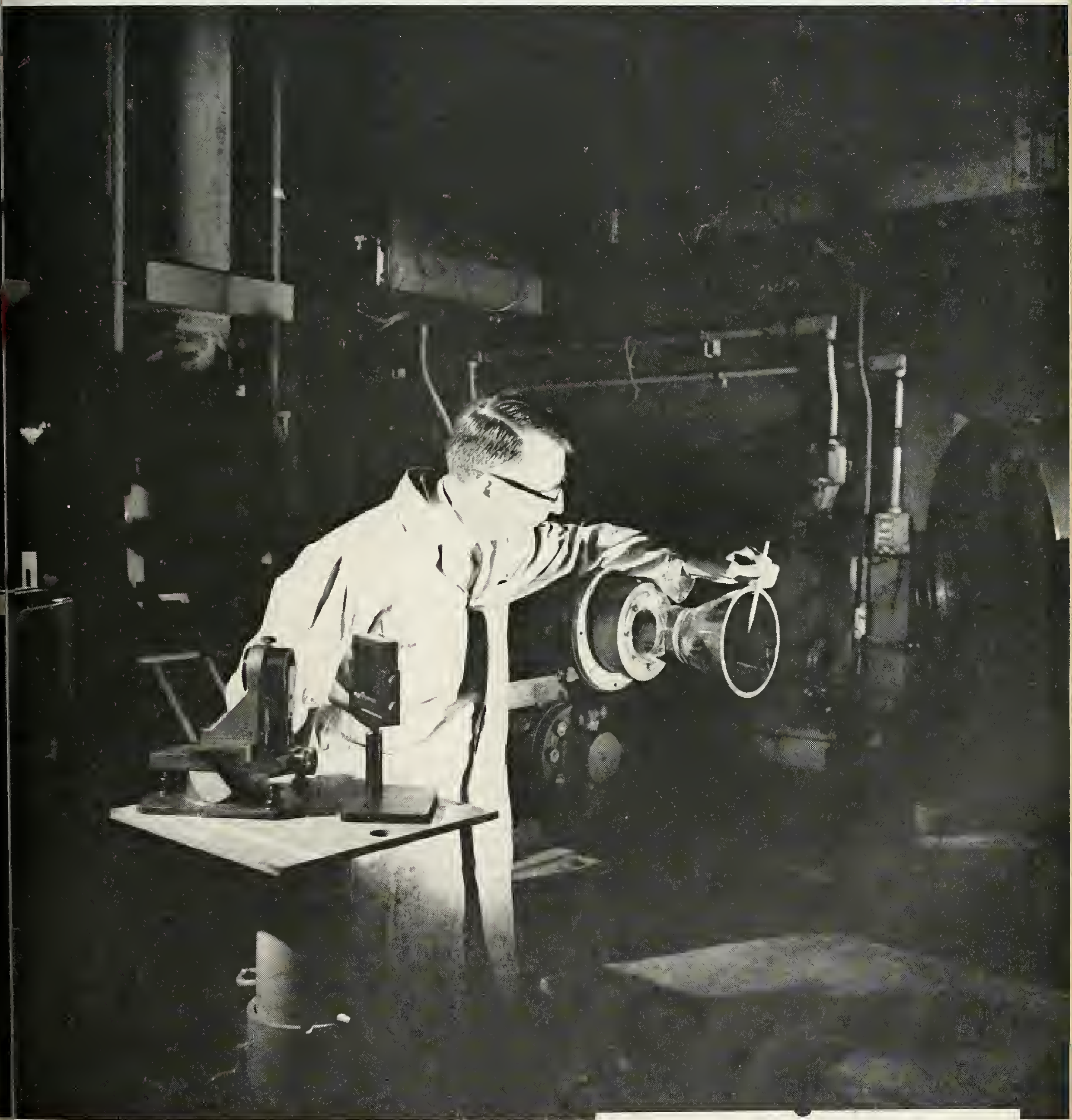

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SURVEILLANCE...
ATTACK...

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BY REPUBLIC'S
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MINEOLA, LONG ISLAND N Y

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December, 1958: Project SCORE. AED developed the communications and control systems for the U.S. Army Signal Corps' "Talking Atlas", part of a program under ARPA, Dept. of Defense. Transmitters, receivers and control units in the satellite and at the ground stations all operated perfectly as the "Talking Atlas" broadcast the President's Christmas message and proved the feasibility of active communications satellites.

April, 1960: TIROS I. The sophisticated satellite, including ts structural design as well as the electronic systems, and its ground stations were developed and built for NASA by AED under the technical direction of the U.S. Army Signal Corps. t accomplished its mission in meteorological observation, sending down over 20,000 TV pictures of earth and its cloud cover.

August, 1960: Project ECHO. The only electronic equipment on this 100-foot balloon, launched by NASA to prove the feasibility of passive communications satellites, are two "dinner plate" beacon transmitters 10 inches across by ⅜ inch thick, including storage batteries and solar cells. These units, designed to permit beacon tracking of the satellite, weigh only 11 ounces apiece and were developed and built by AED.

As more and more sophisticated space systems are developed, AED will continue to design for reliability in this most demanding of all environments. To find out how you can draw on this dependable R&D capability, contact the Manager, Marketing, RCA Astro-Electronics Division. If you are interested in participating in this challenging team effort, contact the Employment Manager, Astro-Electronics Division, Defense Electronics Products, at RCA's "Space Center" in Princeton, N. J.

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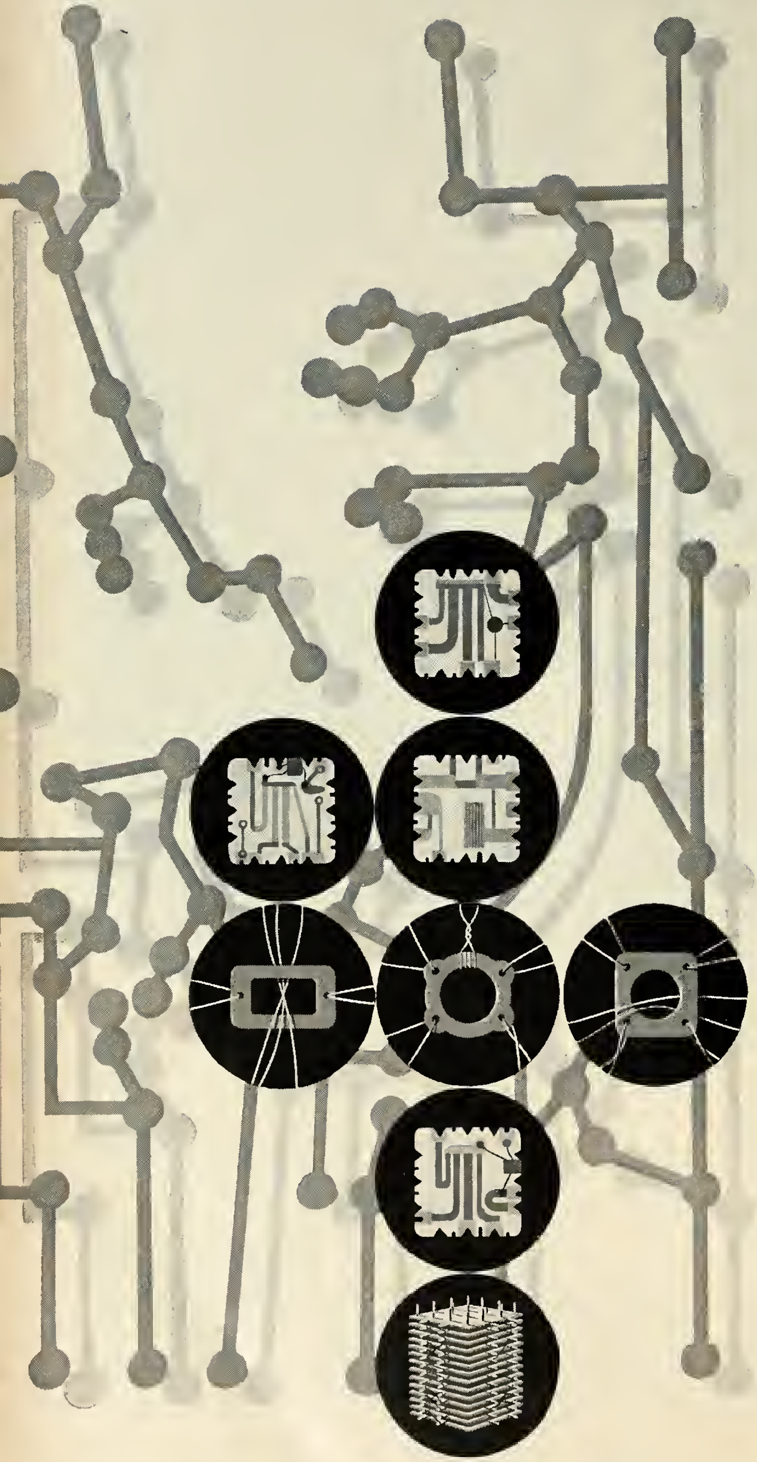

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Advanced research programs are being carried on in such areas as: Switching theory • Modular codes • Logical design • Mechanical language translation • Digital system theory • Ferrite-wire logic circuits • Tunnel diode circuits • Microwave digital techniques • Magnetic thin films • Micro circuitry

Engineers and Scientists who are able to make contributions in these areas are invited to write to: Research and Development Staff, Dept. K-29A, 962 West El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed

MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM; The Air Force AGENA Satellite in the DISCOVERER, MIDAS and SAMOS Programs

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THE COVER

Photo records of light variations caused by internal air flow through transparent nozzle models help Allison to achieve high-velocity exhaust flow. See p. 22.

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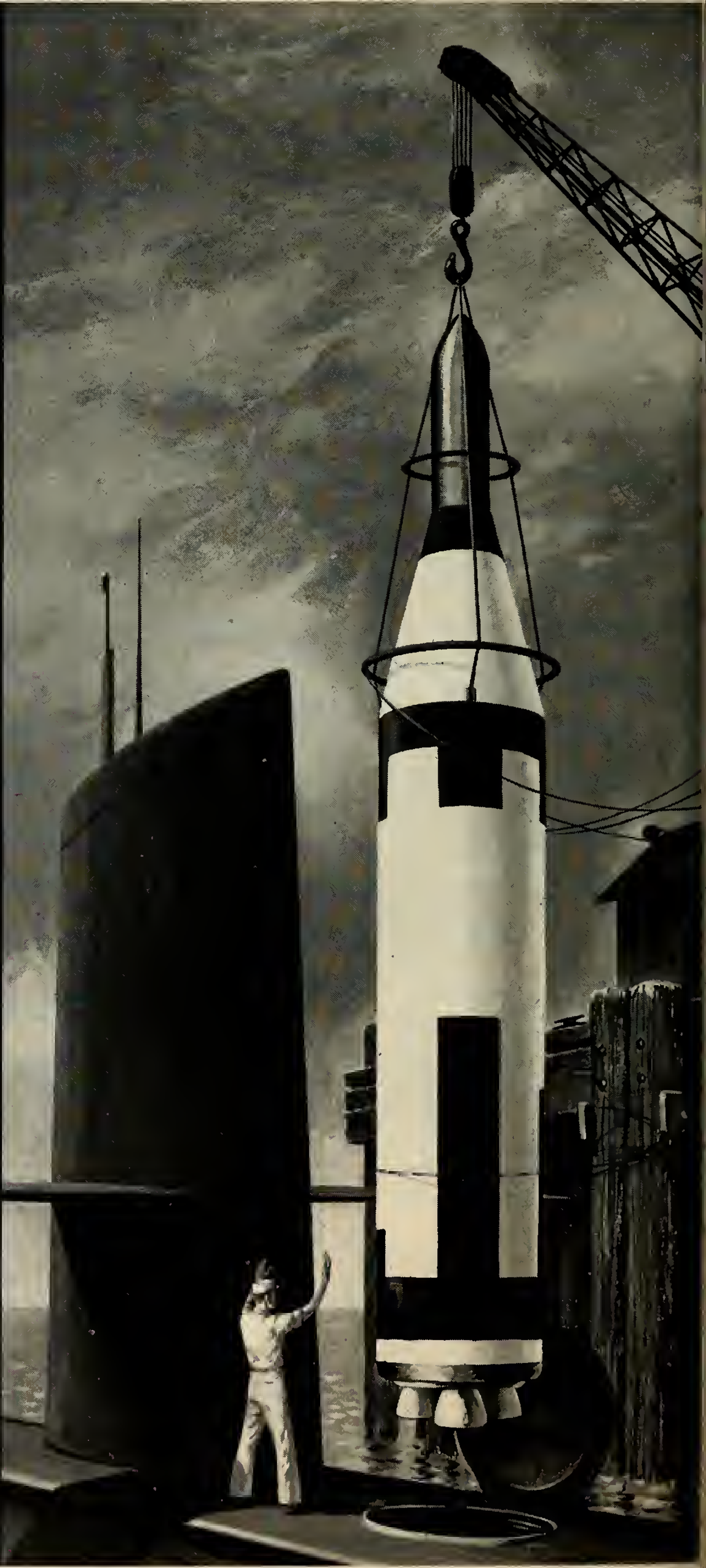


Engineers, scientists—investigate outstanding opportunities at Aerojet

The Countdown

WASHINGTON

nti-Tank Choice May Be Near—Again

The secret recommendation of Army evaluators on which company should get the nod in the hot international competition to sell the Army anti-tank missiles continues to languish in top Army echelons. However, insiders again are saying an announcement may come soon. One possible straw in the wind: Army industrial officials are reported to be talking to Boelkow officials in West Germany about *Cobra.*

-70, Skybolt Still Wed in AF Eyes

Despite the present B-70 R&D program's failure to include plans to carry the Douglas *Skybolt,* the Air Force has privately made clear that the *Skybolt* is still very much in the picture. Taking *Skybolt* away from the B-70 is nothing less than degrading sharply the big bomber's value as a weapon.

Minuteman Troubles Denied

Rumors that R&D guidance problems might force postponement of plans to launch the first test *Minuteman* with all major components in December are being scotched by the Air Force. As one informed source put it: "The December shot still stands."

oubts on Neutron Bomb Warheads

The value of developing lightweight N-bomb warheads for tactical missiles is being questioned by some military experts. The drawback: The N-bomb, which kills by radiation, doesn't necessarily kill quickly. The result: The doomed victims become very, very angry and very, very brave.

ir-launched Satellites, Ahoy!

The Navy is understood to be planning a new attempt to launch a satellite next year with an airborne booster. The satellite will be carried in the nose of the new *Caleb* four-stage solid-propellant missile under development by NOTS at China Lake. Earlier NOTS airborne satellite launching attempts with other boosters were unsuccessful. However, NOTS has high hopes for doing the job with *Caleb.*

ea Scout for Navy

The Navy is seeking its own version of the AF-NASA *Scout.* It would like to use the all-solid vehicle for a seaborne satellite launcher. Vehicle would consist of a *Polaris* booster and upper stages from the NASA *Scout.*

hen There Were Six—Temporarily

An operation for removal of gall stones is expected to eliminate Astronaut Gordon Cooper as a prospect for making the first manned *Mercury-Redstone* ballistic shot. The Air Force captain will remain in the program, but the assignment probably will be given to one of the other six astronauts, if the shot goes as scheduled early next year. Cooper is expected to be back on flight status in six months.

INDUSTRY

Navy Eyes AF Project 3059 Launch

Hopes for the Navy's Project *Hydra* are now pinned on using the concept as a means of launching huge solid rockets—like the million-lb.-plus-thrust Project 3059 of the Air Force. With *Hydra,* such large vehicles would be launched while floating freely in the ocean, eliminating the need for costly launch pads (M/R, May 2, p. 12).

Build-up for B-70

"Gradual increase" in employment of high-level electronics engineers and scientists is forecast by Motorola with its reinstatement as a major B-70 sub. Motorola is developing mission and traffic control system for the Mach 3 bomber at its Scottsdale, Ariz., headquarters.

Testing Zeus 'Jet Head'

Lack of space at its White Sands Missile Range is forcing the Army to test the *Nike-Zeus* "jet head" terminal guidance component at Point Mugu, Calif., home of the Navy's PMR. Tests of the fully assembled bird against a missile will be conducted from Kwajalein Atoll in the Pacific.

INTERNATIONAL

Britain Buying Sidewinders

The Royal Navy's new Scimitar fighter will be equipped with U.S. air-to-air *Sidewinders*—instead of the de Havilland *Firestreak.* Main reasons for the switch: The Scimitar isn't suited to the *Firestreak's* launcher and cost (about $2500 per *Sidewinder* against $22,500 for a *Firestreak.)*

Improved Thunderbird on Way

Full development of English Electric's advanced (Mark II) *Thunderbird* air defense missile is being authorized by the British Government, with the intention of fully equipping the Army as soon as possible. Big improvement is said to be in the solid-fueled bird's 25-mile range. Mark I *Thunderbird* is now going into two heavy anti-aircraft regiments.

French Space Group Formed

France has created a space R&D organization called Comité d'Action Scientifique de la Défense Nationale. The new group will work with Centre National d'Etude des Télécommunications which has been involved in North African rocket tests.

Overseas Pipeline

The French are having second thoughts on joining Britain's "Space Club," if the *Blue Streak* is to be the club's satellite launcher. They don't think club members should have to pay for completing the development and conversion of the missile . . . A new mail rocket (containing 320 postcards) has been launched successfully by the Deutsche Raketengesellshaft of Bremen . . . British Aircraft Ltd. is making circuit boards for use in next year's U.S.-British satellite shots with *Scout* rockets.

EXCLUSIVE . . .

A Kennedy Priority:

How He Will Overhaul the Pentagon

by Clarke Newlon

A COMPLETE reorganization of the Department of Defense will be proposed by the Kennedy administration to the new Congress as one of the first orders of business in January, 1961.

The reorganization would include:

–Abolishing the positions of the three service secretaries—Army, Navy and Air Force.

–Appointing a single chief of staff for the Department of Defense.

–Establishing a single overall war plan for the three services.

–Retaining the three individual services but establishing integrated, unified commands by missions, with these five most likely: 1) Strategic; 2) Mobile Striking Force; 3) American Defense; 4) Research & Development; 5) Logistic. (Pacific and Atlantic Commands might be included.)

These moves will be included in a comprehensive bill to be introduced by Stuart Symington, senator from Missouri and member of the Senate Armed Services and Space Committees. The measure probably will encompass many other Pentagon changes.

It would propose identical effectiveness reports on military officers, with an integrated promotion system to follow.

It would abolish all of the present assistant secretaries of the services, as well as the secretaries.

It would strengthen and centralize the power of the Secretary of Defense, combining many of the functions currently under the services and placing them in DOD.

It would abolish the Joint Chiefs of Staff as a decision-making body and make the Chief of Staff of Defense the nation's top military officer.

The business of reorganizing the Pentagon has occupied Sen. Symington for several years, probably since his own tenure there as first Secretary of the Air Force, when DOD was formed as a small policy-making organization.

• **Key committee**—The reorganization which will be proposed in January, however, comes as the result of the work of a committee appointed by President-elect shortly after nomination. The group, under the chairmanship of Symington, is composed of:

Clark M. Clifford, lawyer, former Special Counsel to President Truman and one of the drafters of the National Security Act of 1947.

Thomas K. Finletter, lawyer, forme Secretary of Air Force and Chairma of the Presidential Air Policy Co mittee.

Roswell L. Gilpatric, lawyer, form Under Secretary of Air Force and mer ber of The Rockefeller Special Studi Project.

Fowler Hamilton, lawyer, former with Attorney General and Justice D partment, former General Counsel Se ate Subcommittee on Air Power.

Marx Leva, lawyer, former Assi tant Secretary of Defense and Chai man, Civilian-Military Review Pan for Special Committee of U.S. Senat

Executive Director of the commi tee is Dr. Edward Welsh, economi and present legislative assistant to Se Symington.

• **No new studies**—In naming t group, Kennedy said:

"The work of the Committee w be focused upon the administration a management of the Defense Depar ment and related defense agencies a organizations.

"The Committee will not make a other sweeping investigation or study defense, military policies and resourc such as have been so ably and thoroug ly done in recent years by vario

Leading Prospects for Secretary of Defense

SYMINGTON

GILPATRIC

SPECULATION as to who President-Elect Kennedy will name to be Secretary of Defense centers on three men, all members of the committee Kennedy named to draw up a reorganization plan. They are:

Stuart Symington, Senator from Missouri, first Secretary of Air Force and arch critic of the Defense establishment. Symington has said recently that he is "not interested" in becoming DOD Secretary, wants to stay in the Senate. Those close to him, however, know that he is itching to get his hands on the five-sided setup. His decision may depend on how much influence he might wield without becoming Secretary.

Thomas K. Finletter, another former Air Force Secretary, author and student of politics. Finletter is known to want State first, Defense second. His age (67 on Nov. 11) could be a deciding factor.

Roswell L. Gilpatric, former Under Secretary of Air Force, might be a dark horse. Kennedy named two committees relating to defense. One was Symington's reorganization group. The other was on foreign policy and defense and is headed by Sen. "Scoop" Jackson (D-Wash.). Gilpatric was the only man named to both committees.

ouse and Senate Committees, and by ich private groups as the Gaither and ockefeller Committees, the Council 1 Foreign Relations, the Foreign olicy Association, the Carnegie Corp-ration, the great universities and hers.

"Rather it will utilize their splendid ork as its primary source for facts, ialyses and informed opinion on the irrow field of defense management id administration with which it is illed upon to deal.

"The crucial questions are those of dgment as to what changes should made in the organization and administration of our defense agencies to iminate or at least to diminish the esent crippling effect of those probms upon our defense power."

Kennedy forecast his reorganizaon plan in his reply to the MISSILES ND ROCKETS open letter (M/R, Oct) in which he proposed establishment unified commands and said of the entagon:

"Certainly defense regulations and ocedures must be simplified, and the oliferation of secretaries, assistant cretaries, undersecretaries, special asstants and deputy assistants to secreries, boards, commissions, councils id committees must be rolled back."

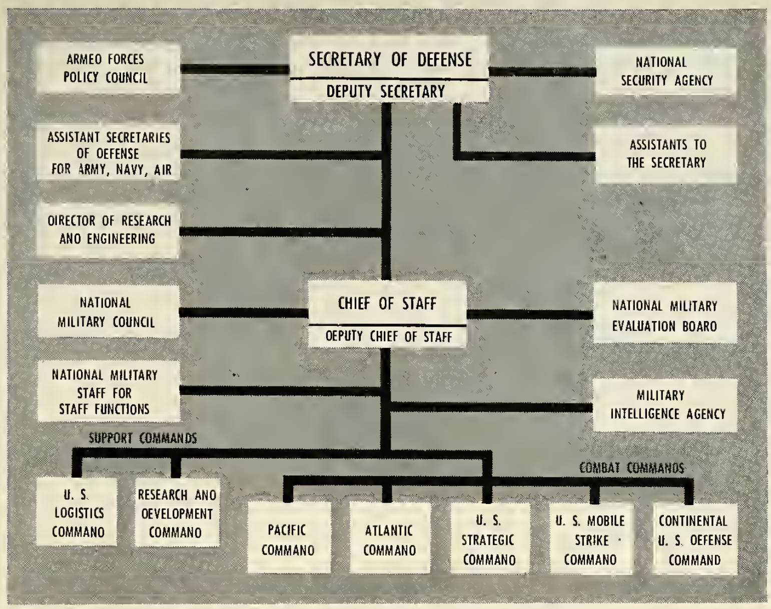
The Symington Committee has been ked to submit its reorganization plan Dec. 31. Upon it, presumably, the Iissouri Senator will base his legislaon.

• **Stormy passage likely**—The reganization plan will carefully skirt iy move to put the military into either ie service or one uniform. Even so it ill face strong opposition from certain ements of both Congress and the ilitary.

The Navy has always been opposed any hint of a single service and has ot favored unified commands even ith Navy in the top position, mostly cause it was establishing a trend toard ultimate unification of the Serves. Rep. Carl Vinson, the Georgia ongressman who is often called the ather of the Navy" is expected to le with Navy views. As chairman of House Armed Services Committee iich he has run with an autocratic nd for years, he could put up formidle opposition.

The Air Force has long favored a gle service and a single uniform, d present AF Chief of Staff General omas White has often so spoken. e Air Force considers it has the domnt military role in the U.S. and as h has little to fear from unification.

The Army would be somewhat opsed, but less so than the Navy. Many my officers feel that the Army role a unified setup would be stronger n it is now. ⌘


SECRETARY OF DEFENSE
DEPUTY SECRETARY
ARMED FORCES POLICY COUNCIL
NATIONAL SECURITY AGENCY
ASSISTANT SECRETARIES OF DEFENSE FOR ARMY, NAVY, AIR
ASSISTANTS TO THE SECRETARY
DIRECTOR OF RESEARCH AND ENGINEERING
NATIONAL MILITARY COUNCIL
CHIEF OF STAFF
DEPUTY CHIEF OF STAFF
NATIONAL MILITARY EVALUATION BOARD
NATIONAL MILITARY STAFF FOR STAFF FUNCTIONS
MILITARY INTELLIGENCE AGENCY
SUPPORT COMMANDS
COMBAT COMMANDS
U. S. LOGISTICS COMMAND
RESEARCH AND DEVELOPMENT COMMAND
PACIFIC COMMAND
ATLANTIC COMMAND
U. S. STRATEGIC COMMAND
U. S. MOBILE STRIKE COMMAND
CONTINENTAL U. S. DEFENSE COMMAND

How Symington Plan Might Reshuffle DOD

THE ACCOMPANYING CHART shows the present thinking behind the Symington DOD reorganization plan, although its details are subject to modification.

Reading from the top, the Armed Forces Policy Council and the National Security Agency would remain much as they are now.

The present Service Secretaries would become either Under or Assistant Secretaries directly on the staff of the Defense Secretary. Assistant secretaries of the services would be abolished.

The assistants to the Secretary would take over the functions formerly performed by the Service Assistants (and frequently duplicated on the DOD level, also.) These would include such functions as manpower, materiel, logistics, research and development, and financial management.

The Director of Research and Engineering would have greater representation from the Services, and greatly expanded powers.

• **JCS replaced**—*The National Military Evaluation Board would function for all Services and would have a greatly increased role of responsibility in military plans of all kinds and in ensuring that they are carried out according to directions of the DOD Chief of Staff.*

The National Military Council is perhaps the key to the success of such a reorganized establishment. The Council would replace the present Joint Chiefs of Staff as an entity, but might include them individually as heads of their services.

The Council would be the top military advisory group. It would do all strategic planning, prepare emergency war plans, logistic, materiel and weapons requirements, budget and personnel estimates.

The Military Intelligence Agency would combine the now individual intelligence organizations of each service.

The National Military staff would handle the normal staff functions for the Department of Defense—logistics, communications, personnel, comptroller, etc.

• **Functional commands**—*The commands are divided into two groups, combat and support. It is possible that in final realization the support commands would report to a civilian official rather than to the Chief of Staff.*

Otherwise, the commands would be functional rather than by service. The Strategic command would merge our present missile and long-range striking forces. The Mobile Strike Command would place the tactical forces of the three Services—probably including the Marines—into a highly mobile force designed for conventional or atomic combat—particularly for localized or small wars.

The Defense Command would encompass the present integrated NORAD and probably take in the present Alaskan and Caribbean Commands.

The Atlantic and Pacific Commands would do little more than unify and group these two into geographical areas, providing room for later expansion if and when it became necessary.

The Logistic Command envisions an ambitious unification of complete logistic functions of all three services into one organization for supply and distribution.

The unified Research and Development Command would propose an eventual amalgamation of all R&D functions under one organization, with personnel and facilities taken from the present military setups.

Exclusive . . .

Joint Strategic Targeting Tackl

New agency headed by SAC's Gen. Power will influence unification of arm services in Kennedy administration; mould future mix of forces

by James Baar and William E. Howard

THE COMING MISSILE GAP is already forcing a new unification of sorts in the Armed forces at the most sensitive level—strategic targeting.

Moreover, this unification is expected to have far reaching and continuous affect on the composition of the long-range strategic striking forces of all three military services under the Kennedy Administration.

This is the underlying significance of the new Joint Strategic Target Planning Staff that has been organized under the Joint Chiefs of Staff and set up at SAC Headquarters at Offutt AFB, Neb.

The Joint Targeting Staff—headed by Gen. Thomas S. Power, SAC commander, with Vice Adm. Edwin N. Parker as staff vice chairman—is responsible for assigning strategic targets for all weapons capable of striking them. One of its first jobs was assigning targets for the 16 nuclear-tipped *Polaris* missiles aboard the submarine George Washington which goes on station this week.

- **Guidance during Gap**—The coming deployment of the first *Polaris* submarines was the overt reason for establishment of the Joint Targeting Staff in late August. However, an even more important reason was the need for the careful husbanding and meticulous integration of all U.S. strategic weapons during the years of the Missile Gap in the early 1960's.

Formerly the assignment of targets for strategic nuclear weapons was handled on a far looser basis.

Officially the services told the Joint Chiefs of Staff what targets they hit and the Joint Chiefs in turn assigned targets to the Air Force and Navy for the bomber, carrier and missile forces. In operation, the services to a great extent prepared to fight their own war.

Under the new system, the Joint Targeting Staff, which is comprised of officers from all services, assigns the targets after thorough study of all available forces and submits the assignments to the Joint Chiefs for final approval. The result is an integrated war pla designed to make the best use of a available strategic weapons.

- **Varied arsenal**—At present, son 90% of the nuclear striking power carried by the SAC bomber fleet. Hov ever, an increasingly larger share wi be provided by SAC's ICBM forc and the Navy's *Polaris* submarines.

Moreover, these forces are suppl mented by the Navy's carrier-base bombers, USAF fighter-bombers an such air-breathing missiles as the *Snar Regulus I, Matador* and *Mace*. In tl next few years there also will be tl Army's 500-mile range *Pershing* an possibly the 1000-mile range *Pe shing II.*

The Joint Targeting Staff when con pletely organized is expected to be con prised of 40 to 50 officers.

Power, besides being chairman, co tinues to command SAC. Parker w reassigned from his post as head the Defense Atomic Support Agenc the organization responsible to the ser ice chiefs for development of nucle weapons, to take on the job of vic

Estimated Strength of Today's U.S. Strategic 'Mix'

OPERATIONAL MISSILES	
Atlas (SAC)	12
Polaris (Navy)	16
Snark (SAC)	20
Matador-Mace (TAC)	250
Regulus Ships (Navy)	5 Subs & 2 Cruisers

OPERATIONAL BOMBERS	
B-47's (SAC)	1000+
B-52's (SAC)	550
B-58's (SAC)	12
Carrier Bombers (Navy)	400 (6th and 7th Fleets)
Fighter Bombers (USAF)	2000

issile Gap

chairman. Army Brig. Gen. Berton Spivey, Jr., serves on the staff as the representative of the Joint Chiefs.

Liaison is maintained with the British for coordinating targeting plans involving the four 15-missile *Thor* squadrons and RAF V-bombers based in Britain. Similar cooperation will be maintained with the Italians and Turks when they get *Jupiter* squadrons operational.

- **Voice in 'mix'**—Although the oint Targeting Staff is physically located at SAC Headquarters, it is organizationally a staff arm of the Joint Chiefs in Washington.

It is decidedly not an operational organization. The targeting assignments are passed along to the various services and commands.

Specifically, this means that SAC's ombers and missiles will continue to e operated from SAC Headquarters and the various Air Force headquarters round the world.

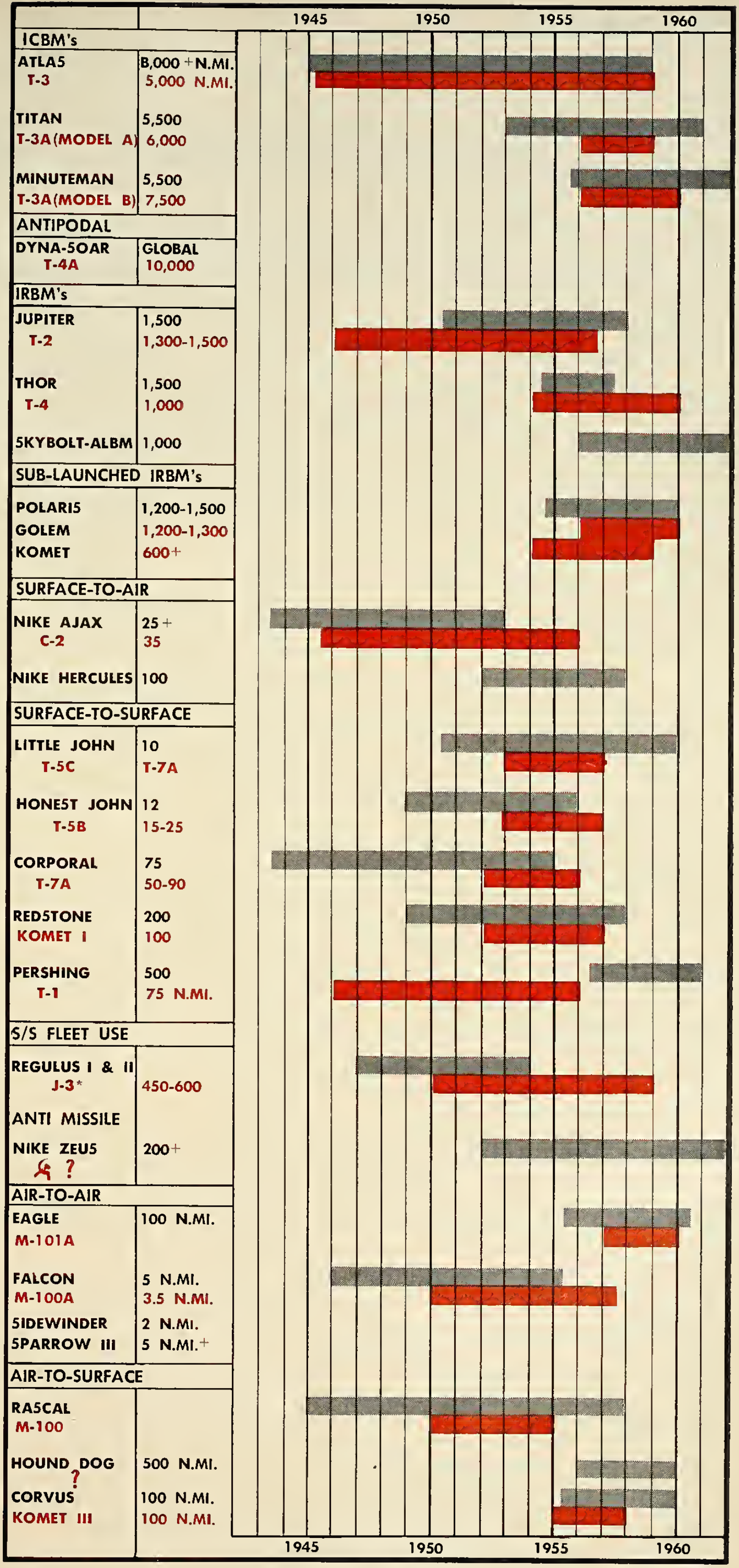
The *Polaris* submarines will operate s part of the Atlantic Fleet under its eadquarters at Norfolk, Va. The carriers will continue to operate as part of he various fleets in the Pacific, Atlantic nd Mediterranean.

But the overall capabilities of all orces are being continually weighed nd reassessed by the Joint Targeting taff. And that staff's conclusions can e expected to have great weight in etermining the "mix" in the years to ome.

⁂

→

EAD TIME LAG of operational issiles is major factor in target planing. The problem is graphically shown y comparing lead times needed for the evelopment of U.S. and Soviet missiles f similar type. The comparative figures own on the chart (right) were comiled by Mrs. Mary G. Page, a research ide at the Operations Research Office f Johns Hopkins University. The chart, ompiled from unclassified sources condered most reliable, was extracted om a paper on the so-called "Deternt Gap."



EXCLUSIVE . . .

Kennedy Will Bolster Space Staff

Pentagon reshuffle has priority, but new administration is expected to keep NASA busy: Space Council's future is uncertain

by Jay Holmes

PRESIDENT-ELECT KENNEDY can be expected to greatly expand the White House staff dealing with space policy.

Kennedy's defense/space advisers believe the bigger staff is necessary to help the new President rule on jurisdictional conflicts between civilian and military space programs. President Eisenhower has one space specialist, Douglas Lord, among the 20 persons in his science advisory office.

The new Administration plans no immediate major moves that would change the balance between military and civilian participation in space programs. Kennedy's advisers are urging him to move first to streamline research and development arrangements within the Department of Defense. Any change in the relationships between DOD and the National Aeronautics and Space Administration would wait until Defense's house is put in order.

Civilian programs will be affected, however, by the Kennedy Administration plan to centralize defense R&D in a single command with line responsibility. At present, the technical staffs of NASA and individual military services often work together on an informal basis, exchanging information and agreeing on apportionment of responsibilities at the lowest level. When the central defense R&D command is formed, defense personnel will probably be authorized to continue existing friendly relationships. But they may need clearance from the highest level before beginning new ones.

• **Plenty of work for NASA**—As for roles and missions, some of Kennedy's advisers believe the newly strengthened defense R&D command should have first call on any program it believes it needs to meet military requirements. The civilian activity would then have the remainder.

However, the new administration believes there will remain a large area of activity for NASA, perhaps even larger than the $1½-billion annual spending rate foreseen by the current administrator, T. Keith Glennan. Kennedy's advisers report most top military men are happy with an arrangement under which NASA supports expensive development projects they will be wanting in a few years, but for which they cannot show an immediate military requirement.

President-elect Kennedy may choose an industry executive as NASA administrator.

No specific names have emerged from early discussions, but there seems to be a general feeling the new administrator should not come from the present NASA staff.

Kennedy's advisers hope to settle on a man of high stature who will be the nation's No. 1 salesman for space exploration. Scientists and engineers can be hired for needed technical advice, they feel, but the boss should be a man with primarily administrative experience. Someone from another government agency is not wholly ruled out.

An obvious problem in hiring a man from industry would be conflict of interest. In campaign speeches, Kennedy has made clear that no one with the remotest interest in government contracts should have authority over an agency spending large sums.

One could draw the conclusion from this attitude that NASA will continue to be responsible for large boosters such as *Saturn* and the bigger one that will follow.

• **New look at Mercury**—There seems to be no inclination to disturb the Project *Mercury* man-in-space program at this stage. However, as *Mercury* passes through the stage of the first demonstration flights in the next year or so, the time will come for consideration of expanding the number of personnel involved.

At that time, the Kennedy Administration can be expected to take a hard look at the highest level to see whether the full capacities of the military services are being used. Certainly, Kennedy advisers indicate that when space exploration goes on an operational basis there is every expectation that military men will be in command.

As for the organization of the purely civilian aspects of space, Kennedy's advisers are thinking about two possible alternative approaches. They are:

–A space czar in the White House.

–Centralization of all non-military scientific research and development in one agency.

The space czar, if appointed, would obviously be in charge of the beefed-up White House staff that is expected to be appointed in any case.

If activities were centralized on a level below the White House, the new agency might take in non-military activities of the Atomic Energy Commission, scientific work in the Commerce Department, the National Science Foundation and some smaller operations in other government departments.

• **Council a question mark**—Completely up in the air is the status of the National Aeronautics and Space Council, a super-body created by the Space Act of 1958. The council, composed of several Cabinet officers and outstanding non-government scientists, was conceived by authors of the act as a policy-making group that would have authority to settle disputes without reference to the White House itself. In practice, President Eisenhower has had to rule on such disputes that have been settled to date.

Authors of the act conceived of a Space Council staff of up to 100 persons, including specialists in each major field. However, the Eisenhower administration appointed only an acting secretary, David Z. Beckler.

The decision on whether to activate the Space Council as originally intended presumably will be made on the basis of recommendations by whoever Kennedy names as NASA administrator. ⌗

ongress may be Critical . . .

Polaris Move to Scotland Stirs Ruckus

THE NUCLEAR-POWERED submarine George Washington—first of the Navy's fleet of *Polaris*-launching submarines—prepared to go on station this eek amid international howls over her eployment.

The center of the controversy connued to be announced U.S. plans to stablish an advanced *Polaris* supply ase in the Scottish waters of Holy och in the Clyde Estuary.

Here was how the situation looked s the George Washington took aboard 6 nuclear-tipped *Polaris* missiles beore departing:

–British groups demanding uniteral nuclear disarmament and Labore leaders in Parliament pressed their rotests against the Conservative Govrnment for agreeing to establishment f the base.

–Britain's Defense Minister Harold Watkinson and Prime Minister Harold Macmillan sought to quell widespread ublic opposition with assurances that he United States would not launch *olarises* anywhere in the world "without the fullest possible previous consultations." However, they stressed that the West came under surprise attack onsultations might be impossible and ndesirable.

–British Labor Party Leader Hugh Gaitskell said he was not satisfied with the assurances. He demanded sufficient British control of *Polaris* subs to prevent their use on "provocative missions" from British bases.

–Frol Kozlov, a top-ranking member of the Soviet Communist Central Committee, warned that by deploying the George Washington the United States and Britain were embarking on a "dangerous adventure." He called the ship's deployment a move "designed to aggrevate sharply the international situation"—a move "fraught with dangerous consequences."

• **Worth the trouble?**—The continued protests that began with the initial announcement of an Anglo-American agreement on the Scottish base earlier this month caused serious questioning in Washington as to the value of the Scottish base.

Some officials also questioned whether the views of the State Department and other government agencies concerned had been sufficiently taken into account by the Pentagon before seeking the agreement.

Polaris submarines will use Holy Loch for the periodic transfer of crews, taking on supplies and some repairs. The big *Polaris* Sub Tender Proteus, a floating drydock and auxiliary craft will be stationed in the Loch.

Use of the overseas facilities will enable the Navy to maintain a greater number of *Polaris* submarines on station continuously by reducing the time used in changing crews and taking on supplies. Without the advanced base, the submarines would have to take the extra time to return periodically to bases in the United States.

Some government officials now are saying that the time gained may not be worth the resulting international complications with the British.

• **Congress may balk**—Nor is this the only harm seen to be resulting from the Scottish base.

One of the attractions of the *Polaris* system is its ability to operate without relying on overseas bases. This has appealed particularly to a number of congressmen.

But now the Navy is establishing an overseas base for *Polaris* submarines anyway. The resulting complications can be expected to receive critical attention in the new Congress when the Navy presents its *Polaris* program for FY 1962.

Meantime, the Navy's Special projects Office proceeded with the development of the advanced 1500-mile *Polaris*. The first test launching was scheduled for later this month.

And at the *Polaris* Depot near Charleston, S.C., the crew of the George Washington made final checks on the big, 6000-ton submarine. Her scheduled sailing date: November 15. ⁂

New Details of Navy Plans for AUTEC Range

CONSTRUCTION OF THE NAVY'S $100-million ASW missile test range in the Bahamas now appears ssured.

Britain last week granted the United States permison to survey the waters of Exhuma Sound and Tongue f the Ocean—where the Navy wants to locate the nge (M/R, Oct. 24, p. 15; Aug. 1, p. 8). This means hat there will be no hitch in Navy Bureau of Ships ans to let a $500,000 study contract next month, overing operation and development of the range. Buildg is expected to start next year.

Several companies are teaming up to become prime r the big new facility called AUTEC (Atlantic Underater Test and Evaluation Center). There is also a comtition under way for the oceanographic survey of the ecific area selected for the range; this is expected to n between $2 million and $3 million.

Further details of plans for the range, first disclosed MISSILES AND ROCKETS also became known last eek. The project's request for proposals indicates that AUTEC is expected to be a vast consumer of instruntation.

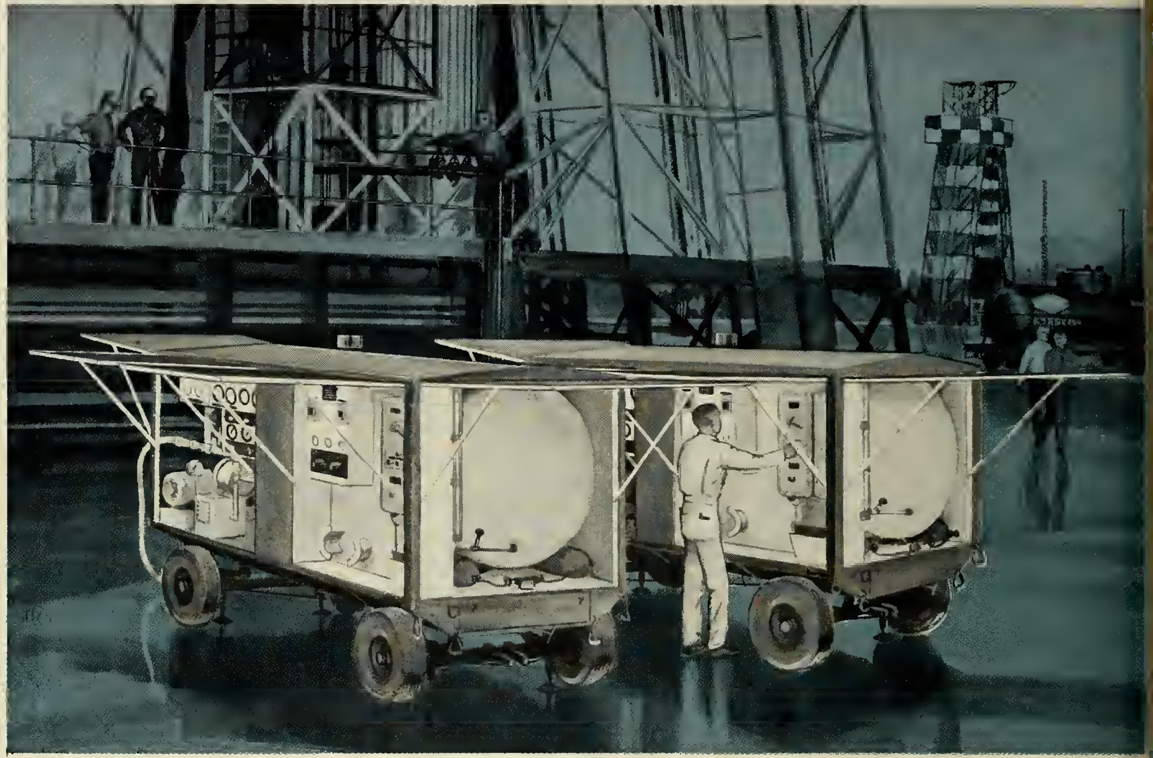
The study proposals being submitted this month are to make analyses of requirements for navigation, tracking and range measurement; communications systems and measurement systems for noise, target strength, and sonar calibration, as well as data transmission and reduction.

Other analyses are to show a layout of AUTEC's subsystems and ranges for testing various types of ASW missiles, in addition to base facilities, new buildings required for "special research," and personnel requirements.

Object of the study is to "insure that optimum systems, compatible and complementary in design, are so selected and planned that orderly development of the AUTEC will be assured with minimum duplication in features or facilities."

Moreover, the study must show projected requirements, capabilities and use-factors of systems proposed for development.

Sources close to the project have made it clear that the Navy is in a hurry to get the range built and in operation. The major consideration is the coming Soviet missile-launching nuclear-powered submarine threat. Many advanced ASW weapons are in the works—but there is no place to test them. ⁂



HOW FMC's CHEMICAL AND MECHANICAL EXPERIENCE SOLVES MISSILE PROPELLANT PROBLEMS

Food Machinery and Chemical Corporation, through its integrated divisional operation, offers a unique capability for the design and production of missile propellant handling equipment.

FMC's chemical background covers years of research development and production of toxic fuels, including high-strength hydrogen peroxide and Dimazine® (UDMH). Utilizing this extensive experience, FMC's Ordnance Division has developed many new processes systems, and equipment for use in solving critical problems in the handling of missile propellants; among them high-accuracy metering equipment, and the Bomarc decontamination system.

For more detailed information on these studies and for experienced counsel on missile fueling problems contact FMC, a leading developer and producer of chemical propellant compounds and the equipment to handle them.

For further information, write on company letterhead to Preliminary Design Engineering Dept., FMC Ordnance Division, P.O. Box 367, San Jose, Calif. Phone CYpress 4-8124.

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION
Ordnance Division
1105 COLEMAN AVENUE, SAN JOSE, CALIF.

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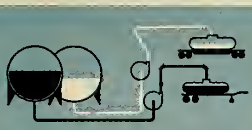
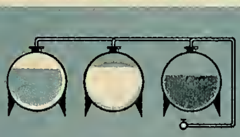
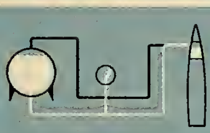
Illustrated below are some of the activities of FMC concerned with missile propellants and propellant handling equipment, which help define a few of the problems successfully solved by utilizing the combination of chemical and mechanical engineering talent available.



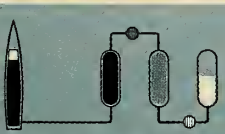
Propellant Handling Equipment



Missile Propellants



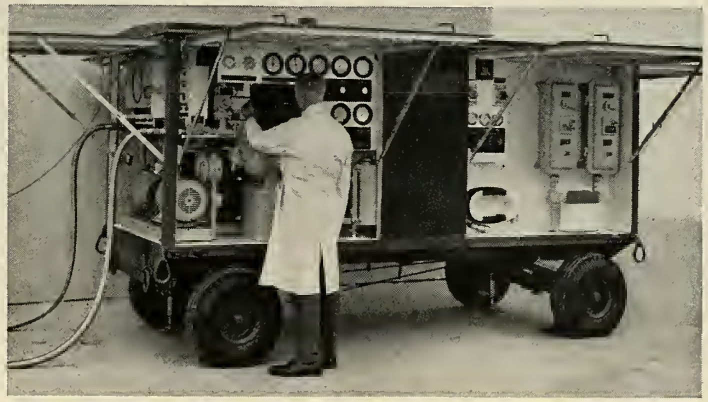
Propellant Metering Systems



Decontamination Systems

Ground Support Equipment

FMC's New Liquid Propellant Metering System Achieves Accuracy to ±0.1%



Mobile metering and control unit for fueling liquid propellant missiles.

The crucial reliability of multistage missiles is influenced by the accurate measurement and delivery of liquid propellant to the missile tanks. For example . . . a small error in fuel weight could adversely affect the in-flight performance of the missile, causing possible failure of the entire mission.

Food Machinery and Chemical Corporation's Ordnance Division has recently developed a mobile liquid propellant metering and handling system which promises to solve many missile fueling problems. The advantages offered by this unique new system are many.

Accurately measures and records the amount of fuel delivered to the missile tanks. Original specifications called for a metering accuracy of ±0.2%. Extensive tests, recorded by precision test equipment, show that the system is capable of metering and delivering missile propellants with far superior accuracy—to ±0.1%.

Automatically compensates for factors influencing fueling accuracy. The fuel is continuously sampled and the flow corrected for variations in temperature and density. In addition, the fuel which vaporizes in the missile tanks is returned to the system, condensed, measured, and an equivalent amount added by the metering unit.

Adaptable to many different missile fuels. The system is designed to handle such storable liquid propellants as hydrazine, nitrogen tetroxide, Dimazine® (UDMH) and nitric acid.

Economical to manufacture and safe to operate. To reduce development, manufacturing and operating costs, the system makes maximum use of standard, interchangeable, and commercially available components. The simple and safe design eliminates human errors and danger to operating personnel.

Mobile and compact. All metering, pumping and control equipment is mounted on a single, portable trailer. The complete unit may be easily transported, rapidly positioned, and provides a single station for the monitoring of fueling operations.

The successful development of this mobile metering and handling system by the engineering staff of FMC's Ordnance Division is another achievement made possible by utilizing the unique combination of chemical and mechanical engineering talent available at Food Machinery and Chemical Corporation.

The Missile/Space Week

Reds Rattle Rockets to Start 'Summit'

Crowded out of the public eye by the presidential election, Communist leaders gathered in Moscow last week presumably to straighten out ideological differences between the Kremlin and Peiping. Setting the tone for the Red "summit" presided over by Premier Khrushchev was a parade of tactical/medium-range missiles and anti-aircraft rockets and a warning from Soviet Defense Minister Malinovshy that Russian Missile might would crush anyone who started a war. The missile parade through Red Square on the 43rd Anniversary of the Bolshevik Revolution also showed off a silver replica of the rocket which the Russians claim downed the U-2 May 1 near Sverdlovsk. Khrushchev, at a Kremlin reception, stuck to booze and boasts—proposing eight toasts to the need for peace and "co-existence."

Report Hits 'Economic Gap'

A report prepared for the Army by Johns Hopkins University's Operations Research Office calls the Cold war "economic gap" with Russia a "threat of inferiority" for U.S. military power. Specifically the report contends that if respective U.S. and Soviet defense spending patterns are continued, by 1970 the U.S. will still be budgeting $46 billion a year against the Russian's $72 billion (in 1959 dollar equivalents.) The study was made last July and disclosed Nov. 5 by the *New York Times.*

AF Probes Titan Management

The Martin Co. management of the *Titan* ICBM program is the first of several major weapon systems undergoing a "management practice" investigation by the Air Force. Aim of the survey is to determine whether "present management methods will continue to keep pace with the rapidly advancing technology of modern weaponry"—and to hold costs at a "reasonable" level.

Super X-15 Still Trying for First Flight

Weather and technical difficulties this last week continued to plague attempts to test fly the *X-15* for the first time with its powerful new XLR-99 rocket engine.

But game North American and Air Force officials planned to try again in a week or so.

The sixth attempt to test fly the *X-15* with the 57,000-lb.-thrust engine was cancelled Nov. 7 when the landing field was left soggy by heavy rains. Five earlier attempts were cancelled by technical difficulties or bad weather.

Early Burnout Foils Blue Scout Jr.

The Air Force had its problems, too, with a *Blue Scout Jr.*

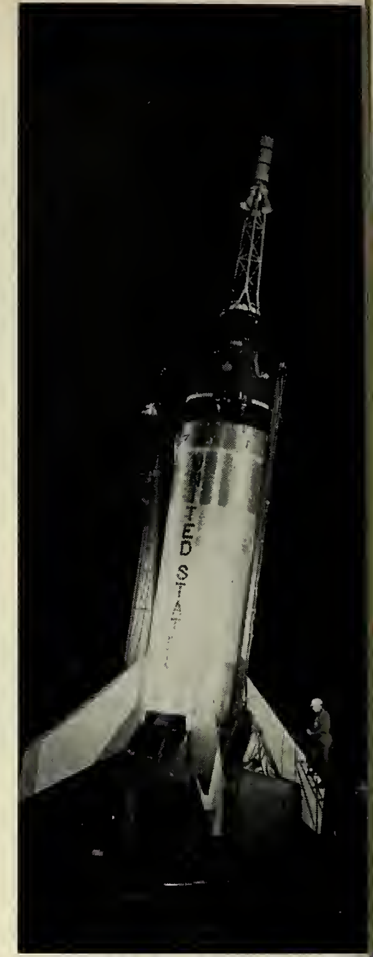
The slim so-called "poor man's rocket" failed Nov. 8 to place a 29.4-lb. payload on a trajectory that would have taken it on a 10-hour trip through space. The instruments were designed to test the possibility of checking up on nuclear tests in space. The payload—crammed with radiation measuring equipment—would have travelled 24,000 miles. However, the *Blue Scout Jr.'s* second stage motor burned out early and the small payload fell into the Atlantic 250 miles from Cape Canaveral.

For Space Communications Dial: UN . . .

There's an old diplomatic saying: If you keep talking, you don't start fighting.

James M. Skinner Jr., president of Philco Corp., has called on the United States to try it by offering to help the United Nations build an international satellite communications network.

Skinner said: "The United States now has the opportunity to give a convincing demonstration of its intention to use its technical achievements in space for peaceful purposes . . ."



New Shot Slated Soon To Test Mercury Escape

Another *Little Joe* booster will b launched soon to test the Project *Me cury* capsule pilot escape system.

The system failed in an Electio Day launching from NASA's Wallop Island, Va., facility. The escape rocke fired at 35,000 ft. as programed, bu a switch malfunction under high ai loading caused failure of capsul separation. The capsule and booste reached an altitude of 53,000 ft. be fore they plunged into 68 to 70 fee of water 13 miles offshore.

The National Aeronautics an Space Administration said a backu booster is available and that the weak ness in the switch will be correcte for the next shot. Last week's *Littl Joe,* the fifth fired, was to have bee the last.

Another *Mercury* test, the firs *Redstone* launching at Cape Canaveral was postponed until this week or later Both *Little Joe* and *Redstone* were t have been fired the day before Elec tion Day.

Douglas Uses PEP to Speed up Skybolt Program

SANTA MONICA, CALIF.—Develop- nent of the Air Force's *Skybolt* mis- ile is being accelerated by use of he new electronic management tech- ique originated for the Navy's *Polaris.*

Details of the new management rogram were reported last week by ouglas Aircraft Co., prime contractor or *Skybolt.* Titled Program Evalua- ion Procedure (PEP), the approach s a direct outgrowth of the Program valuation Review Technique (PERT) stablished for *Polaris.*

Its use on the *Skybolt* program was isclosed earlier in the COUNTDOWN M/R, Nov. 7, p. 7).

Douglas planning official R. A. Hall aid PEP is successfully forecasting otential bottlenecks in the program, naking it possible to speed up the job f arming B-52 bombers with the 000-mile-range air-launched ballistic nissile.

• **Chart to computer**—The Air orce authorized Douglas to proceed ith PEP six months ago. Under the rogram, each step in system develop- nent—design, tooling, testing, procure- nent, quality control and others—is and-drawn on a large chart and re- ated to all other factors influencing s completion by a specified date.

These activities then are assigned umbers and fed to a digital computer y experienced mathematicians. The omputer, after analyzing the data, re- orts on an automatic printer those reas which might cause schedule ippage in the future unless immediate ction is taken.

The first run-through of raw data evealed one activity which might have een 49 weeks behind schedule unless reventative action were taken. Not nly was potential deficit erased, but e department has moved ahead of hedule, Douglas reported.

Direct benefits already achieved in- ude cancellation of a thermocondi- oning test which was found to be nnecessary, re-assignment of wiring evelopment from fixtures to a mock- , and re-assignment of some machin- g work from the Tulsa Division of ouglas to the Long Beach Division.

• **How it functions**—Data from ven major subcontractors, four Doug- s Divisions, three outside locations d one associate contractor have been d into the PEP system.

Inputs from the subcontractors are correlated to Douglas requirements and the firms are informed where they should concentrate their efforts. For example, Nortronics, which is developing *Skybolt* guidance, was shown exactly which pieces of factory check-out equipment required modification and what other engineering steps had to be taken to assure meeting certain completion dates.

In addition to evaluation at Douglas, all data produced by the IBM 709 computer are sent to the USAF *Skybolt* System Program Office, Wright Air Development Division, Ohio.

A Douglas computer technician there processes this and other program data through Royal-McBee LGP 30 or RPC 4000 computers to provide a computer-analyzed look at the entire WS-138A *(Skybolt)* program. The Air Force uses this to plan phasing-in of B-52 bombers and crews, training requirements, logistics support and other action necessary to make *Skybolt* operational in 1964.

• **PERT plus**—PEP improvements over PERT are said to include self-check capability of the computer to identify and pinpoint human errors in entering data into the machine, ability to store and analyze up to 20,000 events, and a system for easily incorporating changes in activity networks that had been processed previously by the computer.

Under Air Force direction, Douglas is providing technical information on PEP program construction to other missile and defense contractors beginning their own programs. These include *Dyna-Soar, Minuteman* and *Nike-Zeus.*

Small Firms' Subcontracts Rise, DOD Awards Drop

Small business' share of fiscal year 1960 Department of Defense prime contract awards slipped $343 million below 1959, but it received a record volume of subcontracts from large companies enrolled in the defense small business sub-contracting program.

Prime contracts awarded to small business in FY 1960 totaled $3.440 billion. This combined with the $3.578 billion in subcontracts brings total contract awards to small business to the four-year average rate of more than $7 billion annually.

DOD said the decrease in prime contracts was part of an overall trend. It also cited the increasing amount of awards going to research, development and production of missile systems and other complex weapons.

"The reported volume of subcontract payments to small business firms is understated," the Department reported. Since the small business subcontracting program was changed from a voluntary to a mandatory basis in January, 1960, it had little if any effect on the number of contractors reporting subcontract payments in the January-June 1960 period.

A total of 293 large companies were enrolled in the Defense Small Business subcontracting Program in FY 1960.

Sylvania Receives Army Quality Control Award

The Army Signal Corps last week presented its RIQAP (Reduced Inspection Quality Assurance Plan) award to the Semiconductor Division of Sylvania Electric Products. The award represents Army approval of Sylvania's quality control methods and test procedures.

Through RIQAP, the Army puts increased reliance on a manufacturer's control policies and practices, aiming at a reduction in the amount of end-product inspection by Government agencies.

AF, SRI Seek to Cut Human-caused Failures

The Air Force is working with design engineers to reduce the number of human-initiated failures in missile systems—estimated in a recent study at 20% to 53% of reported equipment failures and 16% to 23% of unscheduled holds.

The Air Force's Aerospace Medical Division and Stanford Research Institute reported that a "significant portion" of the 4248 malfunctions on nine programs were human-initiated.

Little if any systematic human factors performance testing is done, the report stated. The Air Force termed "critical" the inadequacy of present malfunction data in pinpointing cause or degree of human error.

The largest number of failure or hold reports for any one missile was 1391, smallest 130. The system with the largest number of failures had a 23% rate of human initiated failures.

Another independent report made by a major missile manufacturer attributed 30% to 50% of reported equipment failures and 15% to 25% of unscheduled holds to human error or omission.

For
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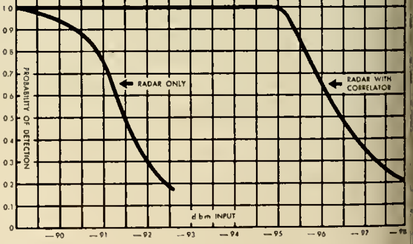
pounds . . .

WHAT AN IMPROVEMENT IN RADAR PERFORMANCE!

This new Video Correlator is now available as a plug-in unit for fire-control and search radars both airborne and ground-based. Flight and laboratory tests have proved that this compact, 0.3 cubic foot radar augmentation device: • makes target detection certain • serves as an effective counter-countermeasure • reduces interference from other radars • eliminates external and self-generated radar noise. Vought Electronics designed the unit for easy back-fitting into existing systems. It contains its own power supply and requires only a simple rigid mounting somewhere in the aircraft.

HERE'S HOW VOUGHT ELECTRONICS' VIDEO CORRELATOR INCREASES THE PROBABILITY OF DETECTION WITH ONE EXISTING FIRE-CONTROL RADAR . . . . .



FOR FURTHER DETAILS ON ANY ONE OF THE MANY APPLICATIONS OF THIS RADAR ENHANCEMENT DEVICE, WRITE:

CHANCE VOUGHT ELECTRONICS DIVISION DALLAS, TEXAS

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Technical Countdown

ELECTRONICS

Dyna-Soar Guidance Draws 12 Contenders

Twelve proposals for the *Dyna-Soar* inertial guidance system prime contract have been submitted to the weapon system project office for evaluation. The award is expected by early 1961. Among those bidding are AC Spark Plug, American Bosch Arma, Eclipse-Pioneer Div. of Bendix, Burroughs and Astro Space Corp., Litton Industries (also chosen as backup by Boeing, associate prime for the weapon system), Kearfott Div. (with Librascope) of G.P.I., General Electric, Hughes, and Sperry Gyroscope.

Smaller Paramp for Space Application

A new type of parametric amplifier developed by RCA shows promise of reducing the size and weight of paramps for satellite communications systems, telemetry, and radar. The device uses a helix as a slow-wave structure distributively coupled with variable capacitance solid-state diodes. Net gains as high as 38 db and terminal noise figures down to 4.5 db have reportedly been measured with the amplifiers.

ECM Nose Cone Being Evaluated

An ablative nose cone with built-in electronic countermeasures is being evaluated by Sperry Rand. Developed by an Australian scientist, the proposed nose cone is reported to have a special skin structure and contains an electronic device to confuse enemy radar.

PROPULSION ENGINEERING

Three-engine Start a Weighty Problem

A three-year development program of 10 flights has been laid out for the *Atlas-Centaur* launch vehicle, beginning next year. All will be primarily for vehicle development, although some payloads will be carried as excess baggage. Big *Centaur* problem is the three engine starts for the upper stage: first to get into a low orbit, next to lift to a 24-hour orbit, and finally to brake into the 24-hour orbit.

Scout Payload Increase Possible

NASA figures it can improve the 150-200-lb. orbital capacity of *Scout* by about 40% by uprating the two upper stages. Latest word is that the first two stages will remain unchanged.

ADVANCED MATERIALS

Re-entry Studied for Anti-ICBM

Maximum effectiveness of anti-missile defense systems will depend on relating physical phenomena of vehicle re-entry to down-range observations. For this reason, GE scientists at MSVD are taking a detailed look at re-entry under the Army's sponsorship. Adequate information on the characteristics of a vehicle can lead to knowledge of its probable mission.

Army Gets C_2H_2 From JP-4

The old calcium-carbide method of producing acetylene gas may be rendered obsolete with the development of an Army field unit weighing 40,000 lbs. Developed by the Institute of Gas Technology, the plant has a design production capacity of 500 cu. ft./hr. of the gas, generated by thermally cracking JP-4 jet fuel.

GROUND SUPPORT EQUIPMENT

Bullpup Simulator Now in Use

Bullpup mission simulators now in use reportedly have almost doubled effectiveness of pilots. Developed by Radiation, Inc. for Martin-Orlando, the AN/ARW-T2 Ground Pilot Trainer is used by the Navy to instruct pilots in the operational aspects of the air-to-ground missile. "Miss distance" is displayed automatically following each simulated mission. Primary electronics in the TV-size console is an analog computer that provides real-time simulation of missile dynamics.

Refraction Error No Problem in Transit

Results of experiments conducted with *Transit 1B* and *2A* R&D navigation satellites has shown researchers that refraction in medium latitudes and under most conditions poses no problem in attaining desired accuracies. Follow-on work will study the refraction problem in auroral zones and during periods of intense auroral activity.

Checkout for Future Weapons Studied

Motorola and Douglas have teamed to conduct a study to establish next-generation design and maintenance criteria for future Air Force weapon systems and associated test and checkout equipment. Results could have major influence on AF planning for support of future weapons.

Giant Radio Telescope Has Troubles

Construction of Navy's big 600-ft. radio telescope at Sugar Grove, W. Va., has run into both time and money problems. The job, originally estimated at $60 million, is now expected to cost close to $97 million. Completion date has been moved up to 1964. No basic design changes are contemplated.

Navy Antenna Being Improved

Modifications under way on Navy's Maryland Pt. 84-ft. antenna will change its size to 85 feet, improve the reflecting surface, and increase its focal length to permit higher frequencies for use as a radio telescope. Improvements are not expected to be completed in time to try a radar bounce off Venus next Spring.

ASTRONAUTICAL STUDIES

Drag Brake Considered for Apollo

Avco's variable geometry drag brake will be one of the solutions considered for the *Apollo* re-entry vehicle under a subcontract with Convair, which has one of three competing studies on the NASA 3-man space ship.

Space-Rendezvous Bids Due Next Week

Atlas-Agena B will be used to test early NASA space-rendezvous concepts a year or two from now. Meanwhile, the civilian agency hopes to benefit by fallout from the more urgent Air Force *Saint* program. Bids on rendezvous studies are due Nov. 21 at NASA-Huntsville.

An M/R Exclusive . . .

ANNA to Spot Targets within 50 Ft.

Pentagon takes over former NASA project, prepares to push geodetic satellite shots which could vastly improve accuracy

by William Beller

WITHIN A YEAR, U.S. missiles could be made able to descend on Soviet targets with nearly pinpoint accuracy. This is one of the big arguments pushing the Pentagon into giving a fast go-ahead to Project *ANNA*, a geodetic satellite program.

It probably is also one reason why the project has been taken away from the National Aeronautics and Space Administration, which is concerned strictly with non-military aspects of space.

"It's just about a going project now," a high government official told M/R, and most likely will be getting final approval within the next few weeks.

A staff member in the Director of Defense Research and Development's office added that "details about the project are classified."

The three services plus NASA are expected to be joint monitors of *ANNA;* hence its name—an acronym for Army-NASA-Navy-Air Force.

The high value of a geodetic satellite lies in using it to find precise distances between land masses. For instance, because of the present uncertainty in measuring the distance between a point in North America and one in Europe, the error in locating Moscow with respect to New York may be as much as 100 meters. This is the estimate of the eminent geodesist Floyd Hough, president of Geonautics, Inc., Washington, D.C.

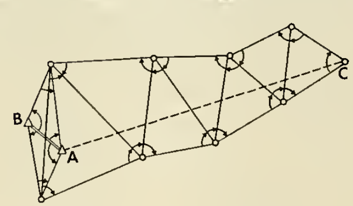
Hough says that with the aid of a geodetic satellite, the error could be reduced to between 10 and 15 meters—less than 50 feet.

Military quarters are almost certain that if the Soviet has not already used one of its *Sputniks* for geodetic purposes, the country surely intends doing so with a future orbiter.

Until recently, NASA has been planning to send up a geodetic satellite on its own. In fact, during 1961 NASA appropriation hearings last February before the House Committee on Science and Astronautics, the agency director of space flight programs, Dr. Abe Silverstein, testified that NASA's fourth *Delta* vehicle would be used for the job.

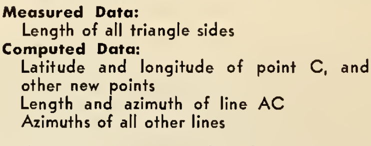
NASA now says that its intent has changed "after renewed analysis, and we have no plans for a geodetic satellite at this time." The fourth *Delta* will be used as a backup for *Tiros*, according to the agency.

• **Details of the orbiter**—Considering unclassified studies, we can surmise this much: The proposed geodetic satellite will probably be modest-sized, weighing only between 50 and 100 pounds. Most likely it will be spherically-shaped in order to keep its drag low and make possible an accurat ephemeris.



Known Data:
Length of base line AB
Latitude and longitude of points A and B
Azimuth of line AB
Measured Data:
Angles to new control points
Computed Data:
Latitude and longitude of point C, and other new points
Length and azimuth of line AC
Lengths and azimuths of all other lines

EXAMPLE OF a simple triangulation net.



Known Data:
Length of base line AB
Latitude and longitude of points A and B
Azimuth of line AB
Measured Data:
Length of all triangle sides
Computed Data:
Latitude and longitude of point C, and other new points
Length and azimuth of line AC
Azimuths of all other lines

EXAMPLE OF a simple trilateration net.

If both optical and radar-tran ponder equipment is used for trackin the satellite, the scientific payloa would be close to the 100-lb. figur The apparatus on board might includ a transponder for receiving and sendin signals, a doppler radio system, strob lights or pyrotechnic flares for use wit fixed and ballistic cameras, and an ac curate clock which would control th timing of light flashes.

NASA's *Scout* could be the launch ing vehicle. This all-solid four-stag rocket had its first successful flight la month, and is thought capable of pu ting between 150 and 200 pounds int a nominal orbit—300 nautical mile This payload is probably more tha a geodetic satellite would need bu could be traded off for a higher orbi

The Air Force's *Scout* with guic ance in its fourth stage, *Blue Scout I,* would carry a lesser payload and woul have the advantage of putting it into more precise orbit—a significant ac vantage for a geodetic satellite.

• **Eratosthenes called it round**—It strange that for man to know the siz and shape of the earth, he must leav the earth. Still, remarkable approxima tions have been made of the measure ments of the planet, dating back t the work of the Greek geographe philosopher Eratosthenes, who live during the third century B.C.

He said that the earth is a spher and on the basis of additional assump tions, observations and "true" facts, h calculated its circumference to be 24 660 miles. This figure is surprisingl close to the currently accepted valu for the earth's circumference at th equator of 24,899 miles.

Nineteen hundred years later, a international scientific controversy aros about the shape of the earth. To hel settle the argument, The French Acac emy of Sciences in 1735 sent a geodeti expedition to the Spanish province c Peru—later to become Ecuador—t measure the length of a meridian de gree close to the equator; and anothe expedition to Lapland to make a simila measurement near the Arctic Circle he longer length of the degree-arc in ne north proved that the earth was attened near its pole. It was then greed that the earth was an ellipsoid.

Measurements taken from satellites how the earth to be pear-shaped, having more mass in its southern hemiphere than in its northern. The averge amount of flattening at the poles s derived from the data is given by ne formula: $a-(b/a)=1/298.3$, where is the earth's semi-major axis; and *b*, s semi-minor.

• **Measuring long distances**—There re two ways a satellite can geodetically e two points together: the intervisible ethod and the orbital method.

The first one requires that simulaneous sightings be made from each f the two base lines that are to be onnected. This is merely an extension nto space of the conventional means of iangulation.

The orbital method calls first for ne precise determination of the satelte orbit, including minor variations rom the Keplerian ellipse caused by nomalous gravity and atmospheric ffects. Then by using the calculated phemeris as an interpolation device, ne can find to high accuracy the relave positions of the observation points.

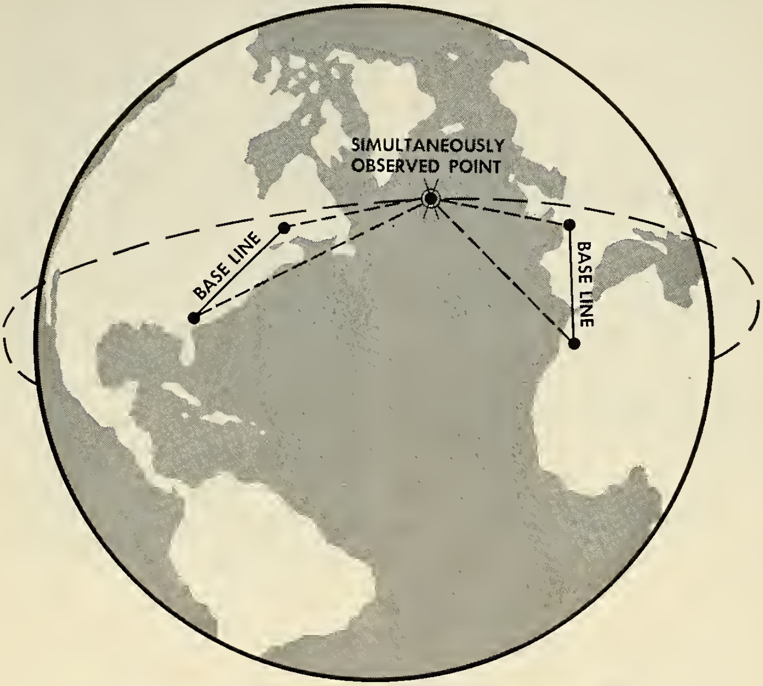
Because the intervisible method alls for the satellite's being visible imultaneously by each datum, the orbit nust be a high one. This results in a veak geometric figure for determining ne satellite position.

The geometric figure used in the rbital method would be enhanced by low orbit. Another advantage is that ong ties are possible because there is o intervisibility requirement. Also, pace coordinates can be used, thereby ielding direct corrections to geocentric oordinates. On the other hand, with ne intervisibility method only relative ositions in geodetic coordinates are btained.

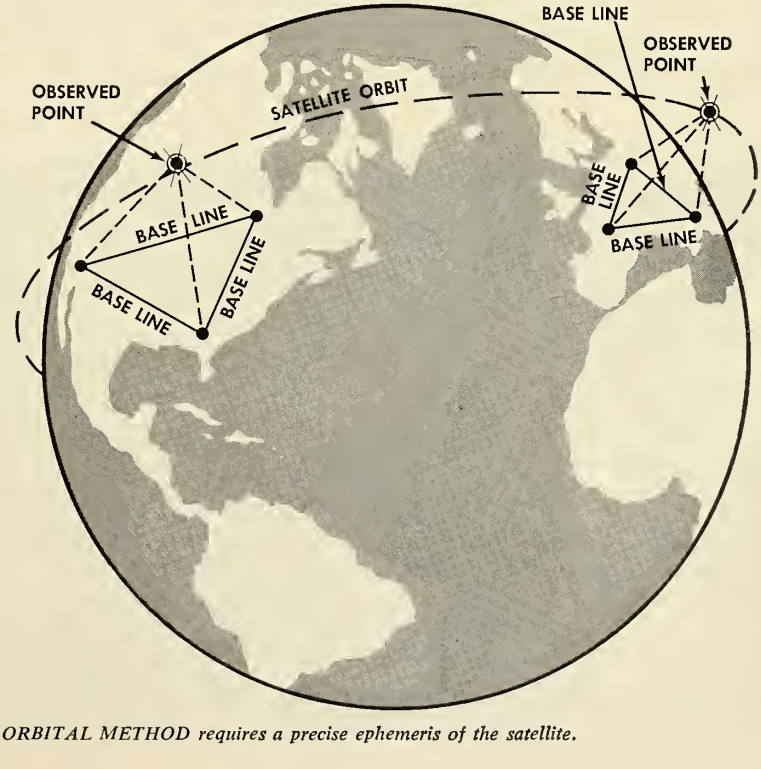
One weakness in the orbital method that uncertainties in knowing atnospheric effects and the local values f gravity may cause uncertainties in etermining the orbit and therefore in nterpolations by means of it; however, or low orbital altitudes the effects of ne uncertainties are quite small.

The intervisible method needs no phemeris. Detailed calculations of the rbit are thereby skirted. Happily, too, ne requirement for timing accuracy much less severe.

The need for classifying a geodetic atellite project is not quite clear. It is aid that the explanation lies somehere in the field of international relaons and the fact that NASA is a nonnilitary agency. This might explain the umor that the services will be footing roject *ANNA's* bill, while NASA assts only as an interested observer. ⁂



INTERVISIBLE METHOD calls for simultaneous sightings of satellite.



ORBITAL METHOD requires a precise ephemeris of the satellite.

Cover Story

Energy Conversion Is Allison's Business

GM Division broadens basic operating concept to fit needs of missile/space era

by John Judge

THE NEW LOOK at Allison Division of General Motors stems from an enlarged conception of the firm's basic business—energy conversion.

Long a respected name in aircraft propulsion, Allison is moving into the missile/space market with a series of programs emphasizing research and experience.

Research and development covers such areas as the preliminary design and development of lightweight compact military reactor power systems, adaption of the Stirling heat engine to space purposes, and magnetofluidynamic rocket research.

In addition, programs are under way in nuclear propulsion, vehicle attitude controls and nozzle cooling systems for solid rockets.

Approximately 40% of Allison's entire effort is tuned toward missile/space and government activities.

• **Liquid metal cells**—Most of the programs involve the indirect conversion of energy. But work is progressing in at least one area of direct conversion—a thermo-electric converter.

The particular converter, or fuel cell, is a thermally regenerative liquid metal system developed by Dr. Bernard Agruss, Chief, Chemistry Section. It has been operated continuously for as long as an hour.

Mobile or stationary units could operate in conjunction with a heat source similar to the compact reactor currently under joint development by Allison and Nuclear Development Corp.

Using a nuclear conversion process, the reactor would be cooled with liquid
metals, thus providing a heat sour
The heating would cause the separati
of the various metals at their boil
points. Their recombination would g
erate an electrical current.

• **Upgraded steels**—Allison was c
of the firms that spearheaded the dr
for premium quality "clean" steels.
began by trying to upgrade the clea
ness and uniformity of steels used
aircraft engine gears and bearings.

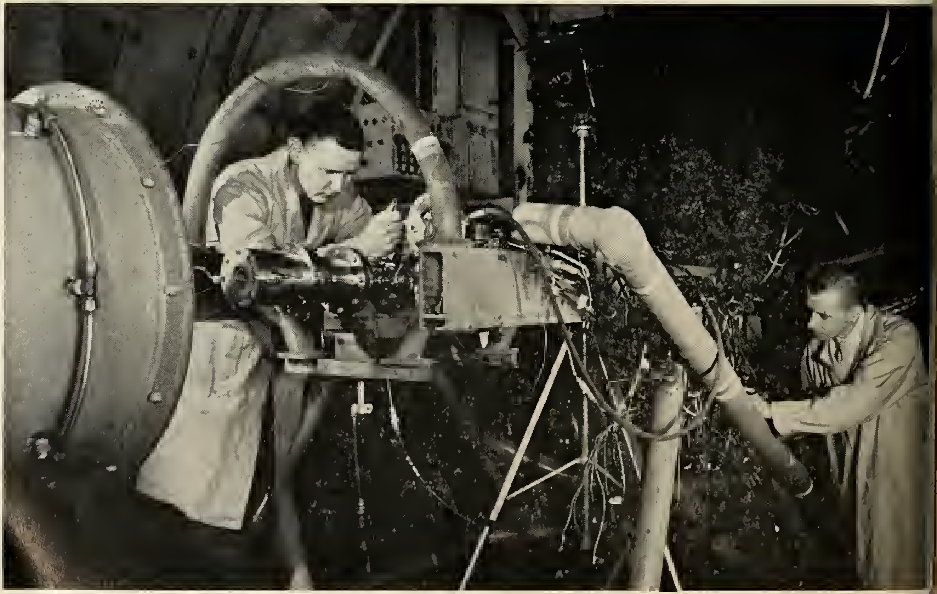
Backed by management, Allis
metallurgists embarked on a qual
control program that extended ri
back to the ingot. A thorough inve
gation led to the adoption of steels p
duced by the double melt-consuma
electrode process.

The campaign resulted in increa
reliability and life in highly stres
aircraft engine parts. Allison then s
the clean steel idea to the Governme
At the time, there was a large price
ference between this premium mel
steel and the ordinary melt; today
costs are substantially the same.

The same type of reasoning
applied to the *Minuteman* case progr
and has contributed heavily to the p
gram's current reliability figure
100%.

Here Allison metallurgists and
gineers worked closely with the Lad
Co., Cudahy, Wis. on Ladish's D6 st
the raw ingredient of *Minuteman's* fi
stage motor cases. Not a single case
been rejected for lack of cleanliness

The steel used in current pre-p
duction *Minuteman* cases is essenti
the Ladish composition. Allison me
lurgists made some changes, larg



EXPERIMENTAL rocket engine designed and built by Allison is powered by pyrophoric fuels.

onsolidated in the lower sulfur, and in he carbon and vanadium range. But hese changes produced a profound ffect on the finished product's major hysical properties.

Allison's work was in part responible for the drawing up of specificaions on AMS 2300, premium aircraft teel.

In the motor case field, Allison is lso looking at roll forming as a posible means of fabricating metal presure vessels. Several studies into reinorced plastics are being made, with articular emphasis on fundamentals. he basic aim is to reach a strength ensity ratio of 2.5 million to 1.

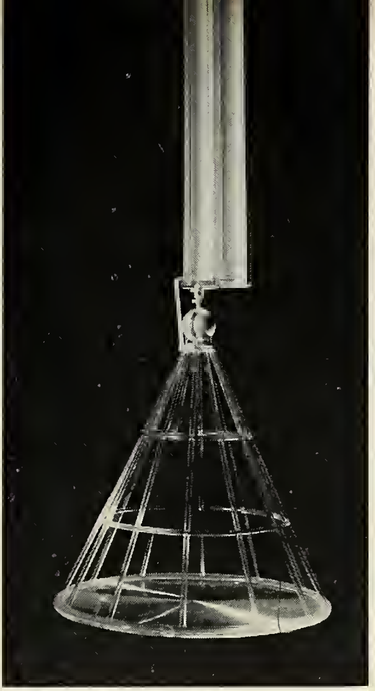
Facilities for winding large bodies ill be in operation early in 1961. These ill be devoted to research and develpment.

• **Space power systems**—Robert tirling, a Scottish clergyman, invented nd built a two-piston, closed-cycle, exernal combustion engine in 1816. Its fficiency was poor, and the Rankine, tto and Diesel cycles effectively renered it obsolete.

In 1938, N. V. Phillips Gloeilampenabrieken, Netherlands, decided to aply modern thermodynamics and heat ransfer theory to the Stirling cycle.

By 1954, a 20-cu.-in. displacement ngine was built, using hydrogen as the orking fluid. It delivered 40 hp at the redicted thermal efficiency of 36% ith a maximum cycle temperature of 300°F.

Under agreements with Phillips, llison is continuing the development f the engine for space power.



STIRLING-CYCLE engine and Fresnel collector such as this could remain unattended and operational for years.

In an ideal situation, considering the relation of efficiency to temperature ratio, the Stirling engine efficiency is identical to that of the Carnot cycle—the highest attainable for any heat engine.

In the Stirling engine, the adiabatics of the Carnot cycle are replaced by constant volume curves and the heat rejection and addition is handled by a regenerator.

Obviously, the regenerator assumes vital importance in the operation of the practical engine. In actual practice, regenerator effectiveness values in excess of 98% have been achieved by Phillips.

The main selling points of the Stirling cycle are that it is a closed cycle system with a wide heating potential, and it is reliable. In addition, the engine is quiet—a desirable quality for certain Military applications.

A consideration of the engine for space auxiliary power brings in several other pieces of hardware—such as a solar collector, an absorber, a generator and a heat rejection system.

Allison is convinced that the best solar collector is a Fresnel reflector. Since the mirror lies practically in a single plane, it lends itself to compact folding. The division has perfected a method of manufacturing these reflectors through electrical deposition.

An ultra-high-temperature laboratory has been in operation for some time. Allison's involvement with refractory metals has resulted in the development of the Plasma-Tung, a spraying instrument capable of running continuously for two to three days.

Further along in this area, the Division has fabricated large pieces of refractory metals with the Plasma-Tung, using a removable mandrel. The physical properties of these pieces, when they are properly heat-treated, have excelled those created by other methods of processing.

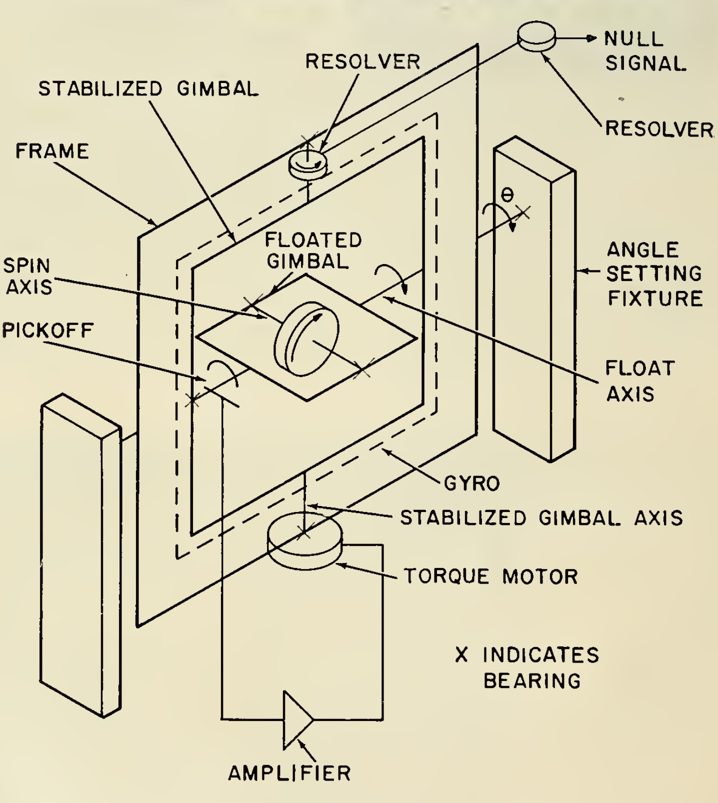
⁂

OWER STEERING for missiles is function of this set of solid-ropellant attitude control rockets. A number of methods are nder study at the Division's Rocket Propulsion Section.

HEAT GENERATED by the arc light is collected by a Fresnel lens and concentrated on the head of a laboratory-model version of the closed cycle Stirling system.

Rigid Drift Tests Give Useful Gyro Data

Lear believes its techniques—already in use in missile programs—can eliminate unexpected drift



FLOATED-GYRO GIMBALLING, used in Lear's tests to obtain useful gyro drift data, is shown in this diagram of the equipment arrangement.

by Wilbur A. Carrington*

GRAND RAPIDS, MICH.—Gyro
gineers, at Lear, Inc., have develo
drift tests for bench use that simul
the most severe missile environme
and yield truly meaningful data.

Techniques throughout industry
drift evaluation of gyroscopes h
varied widely as knowledge has
creased, design techniques have gro
more sophisticated, and application
quirements have become more string
In testing gyros for severe envir
mental missile applications, Lear
lieves it has developed significant r
techniques for obtaining the types
data most pertinent to in-flight p
formance analysis.

There are no tougher drift tests
modern industry.

These same tchniques also apply
gyroscopes intended for "easier rid
and might assist in pinpointing cau
of drift more quickly than ear
methods, since the evaluations yi
components of the total drift attrit
able to specific mechanical charac
istics of the structures.

• **Functions simulated**—A ben
testing technique is the approach u
most. Designed to yield the maxim
feasible amount of environmentally
duced drift information, it also sir
lates the function of the gyro in
particular application.

For this illustration, a stable-p
form floated gyro will be considered

Two factors of interest in dr
producing acceleration are "sensiti
and "insensitive" drift sources. T
first includes mass unbalance and a
soelestic mass shifts; bias and rand
ness are sources of insensitive dr
(There are other sources, but th
illustrate the methods used in the g
drift tests.)

Before discussing our test pro
dures, these sources of gyro d
should be defined to provide mut
understanding:

–*Mass Unbalance* is the drift-p
ducing element in a gyro which ma
fests itself as a drift rate proportio
to applied accelerations having co
ponents parallel to the plane of the s
and input axes. In a floated gyro, t
error may result from lack of coir
dence of the center of gravity or cen

**Instrument Systems Engineer, Le*
Incorporated.

INSTANT FLIGHT

Varied stresses of programmed flight will soon be duplicated at ground-level. A $10 million static test facility, designed by Vitro for the U.S. Air Force, will shortly begin operations at Wright-Patterson. Here, major components will be subjected to programmed aero-dynamic heating and dynamic loading of supersonic flight. ■ In eleven major Vitro projects, the precise simulation of unusual environment was vital; twenty-one Vitro projects required design of nuclear containment. This is Vitro know-how.

Vitro

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READING AN INFERNO'S SECRETS...

Missile "silo" concept proved practical by Lockheed Electronics

The U.S. Air Force came to Lockheed Electronics with an extremely complex and urgent problem. Could the tremendous shock and heat of a missile blast-off be accurately measured in launchings from an underground silo?

Lockheed Electronics designed and built a special data-gathering system to analyze, through instrumentation, the searing heat and violent shock of more than 40 test firings. During each test more than 200 measurements were made simultaneously.

Results have produced new understanding of missile stresses, acoustics, thermal radiation, shock and vibration. This vital information is already being applied to the design of "hard" launching sites.

The capabilities of Lockheed Electronics, Information Technology Division extend to all phases of data handling—a fact well worth remembering when you encounter tough problems in this field.

CAPABILITIES—INFORMATION TECHNOLOGY DIVISION

Data processing
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Data reduction and display
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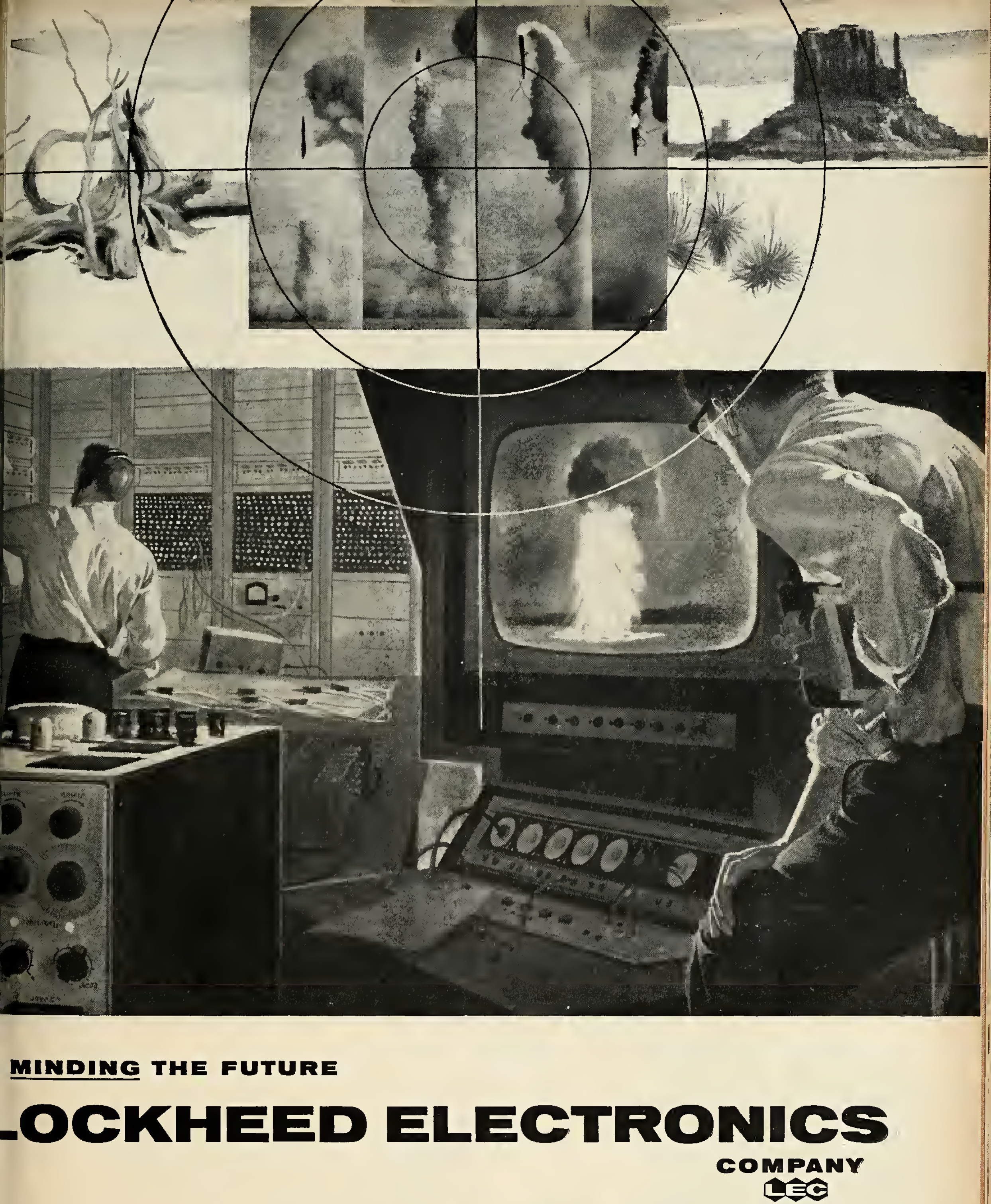

MINDING THE FUTURE

OCKHEED ELECTRONICS

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to exactly set and check angles

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Highly sensitive yet easily handled, the Microptic Precision Clinometer is designed for all calibration and machine setting purposes requiring the highest accuracy.

Angles through 360° are measured by referring the instrument base to the true horizontal — the inclination is read directly from the circle scale through a reading microscope. The eyepiece can be rotated to face in any direction. Interchangeable units permit daylight or artificial illumination of the reading system.

The Precision Clinometer is invaluable in setting inclinable tables for jig borers, and angular work on grinding and lapping machines; for checking angular faces and locations on jigs, fixtures and gages.

. . . New

Accessories—for use in horizontal position; to measure angular displacement of small parts; to comply with military environmental specifications for field use.

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DIVISION OF ENGINEERING AND SCIENTIFIC INSTRUMENTATION
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of buoyancy (accompanied by misflotation) and the output axis-bearing centerline.

–*Anisoelastic Mass Shifts* concerns that drift producing element which manifests itself as a drift rate proportional to the square of applied accelerations. It is caused by elastic deflection of the center of gravity in a direction not parallel to the accelerating force which, in turn, is due to a difference in spring rates along input and spin axes.

–*Bias* is the component of gyro drift that is independent of applied acceleration and is determined by the average of a number of drift tests during which the direction of the acceleration due to gravity is varied in a periodic fashion about the output axis.

–*Randomness* is a measure of the lack of repeatability of gyro drift under identical conditions, or a measure of deviation among drift readings with constant gyro inputs. In this case it is expressed statistically in terms of a "composite" standard deviation found by extracting the root-mean-square of the standard deviations for each group of readings at a constant input position.

• **Floated gimbal used**—In performing the drift tests, the gyro is installed in a gimbal structure designed to introduce an additional degree of freedom relative to an earth-bound frame (see diagram).

This gimbal is often tailored to simulate the inertia, and possibly the friction, anticipated in the gimbal to be stabilized in the application. Angular motions of the floated-gyro gimbal, sensed by a float axis electrical pickoff, are translated into torques about the stabilized gimbal axis through use of a suitable electronic amplifier and torque motor with a polarity that tends to maintain the gyro spin axis perpendicular to the stabilized gimbal axis.

The frame of the test assembly is, in turn, installed in an angular indexing stand capable of positioning the stabilized gimbal axis in any angular position about an axis parallel to the gyro float axis.

Relative angle between the stabilized gimbal and the frame is sensed by a synchro or resolver which, in conjunction with an external, adjustable control transformer or resolver, can yield an electrical null signal. This signal is converted to a visible recording by means of a moving-pen recorder. Motion of the pen versus time from an initially set position is proportional to the sum of two quantities: earth rate and gyro drift. The first of these being accurately predictable, the second is readily calculated.

An initial attitude is chosen with the spin and float axes horizontal and the stabilized axis vertical. Drift runs, generally of 2-minute duration, are performed at 30-degree increments of stabilized gimbal axis relative to vertical, rotating through 360 degrees about the float axis.

The closed loop system acts to maintain the spin axis perpendicular to the gimbal axis during these runs; thus gravity acts at a series of attitudes relative to the float. The gyro is deliberately disturbed between runs.

This procedure is repeated two or more times. Additional runs with the float axis vertical serve to evaluate thrust bearings.

• **Reduction of data**—A plot of drift rate versus gravity angle is fitted by a Fourier series approximation carried out through the second harmonic terms, thus:

Drift rate $= d_0 + d_1 \cos \theta + d_2 \sin \theta + d_3 \cos 2\theta + d_4 \sin 2\theta$ where $d_i =$ drift coefficient, $\theta =$ gravity angle. In this expansion, d_0 is the average drift or bias, d_1, d_2, d_3, and d_4 are the amplitudes of their respective curves expressed in degrees per hour, and have the following significance: d_1 represents the component of mass unbalance parallel to the gyro spin axis, d_2 represents the component of mass unbalance parallel to the stabilized gimbal axis, d_3 and d_4 represent components of anisoelastic drift.

The maximum mass unbalance drift is represented by:

$D_m = \sqrt{d_1{}^2 + d_2{}^2}$ degrees per hour per g.

The maximum anisoelastic drift is given by:

$D_a = \sqrt{d_3{}^2 + d_4{}^2}$ degrees per hour per g^2.

• **Repeated tests necessary**—The interpretation of data derived above yields significant information to the designer concerning major drift causes but is, in itself, only an approximation of drift characteristics. This is the result of random errors in the gyro being tested as well as in the test equipment and procedures. Statistical approaches to the error problem have yielded techniques for handling these variations.

An important parameter is defined as Random Error, determined by repeated performance of drift runs at the 30-degree incremental positions referenced above. It is then possible to estimate randomness by the following expression:

Randomness:

$$\sigma e = \pm\sqrt{\frac{\sum_{i=1}^{n} Yi^3 - \frac{1}{n}\sum_{J=1}^{N/n} Tj^2}{\frac{N}{n}(n-1)}}\ \text{deg./hr.}$$

24 valve problems solved by Clary!

These are just a few of the valves engineered and manufactured by Clary Dynamics.* Each represents an original solution to a different problem. When you have a valve problem, call on Clary –one of the nation's leading suppliers of space craft valves.

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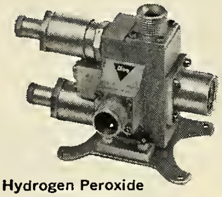
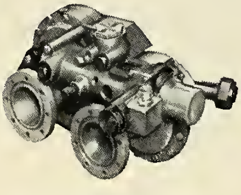
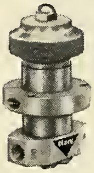
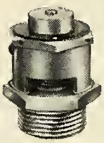
(Titan Missile)


Hydrogen Peroxide
Relief Valve
(X-15 Space Plane)

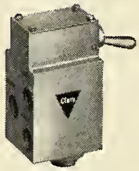

Acid-Aniline Propellant Valve
(Corporal Missile)

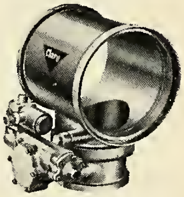
Pneumatic
Actuated Valve
(Hound Dog Missile)

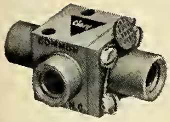

Hand Loader
(Jupiter Missile)


Drain Valve
(C-130 Transport)

Restricter Valve
(F-100 Interceptor)


Toggle Valve
(Hound Dog Missile)


LOX Fill & Drain Valve
(Titan Missile)


Shuttle Valve
(Jupiter Missile)

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Pressure Regulator
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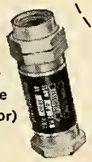
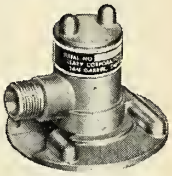
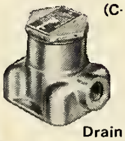

One-Way
Restricter Valve
(F-100 Interceptor)

Drain Valve
(C-130 Transport)

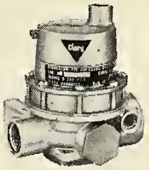

Fuel Drain Valve
(Electra Airliner)

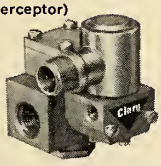
Two-Way
Restricter Valve
(Jet Star Transport)

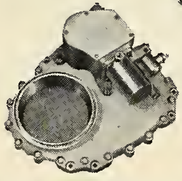

Drain Valve
(Constellation Airliner)

Pressure Regulator
(F-104 Interceptor)

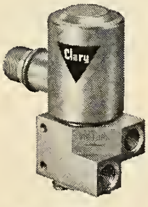
Vacuum & Relief Valve
(Firebee Drone)

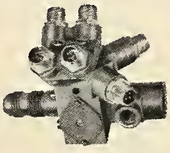

Pressure Regulator
(A3J Vigilante)


Pilot Actuated Solenoid Valve
(In-Flight Refueling)


Blade Valve
(Titan Missile)

Manual Drain Valve
(P3V-1)


Solenoid Valve
(B-52 Jet Bomber)


Squib Valve
(Discoverer Satellite)

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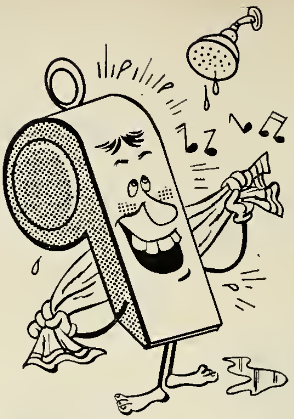
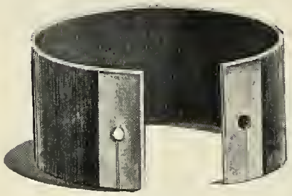
"CLEAN AS A WHISTLE?"



NO...
CLEAN AS A POTENTIOMETER WINDING!



We can't vouch for whistles (despite the number of people who cite them as clean), but we *can* vouch for "pot" windings cleaned ultrasonically in an Acoustica Unit. As produced by one leading Eastern manufacturer, they are so clean that contact noise is practically eliminated, rejects are cut to a near-vanishing point...and cleaning takes only *a sixth of the time* required by older, less sure hand methods. Although residues—varnish, lubricants, dust, fingerprints—are literally and completely *blasted* from the coils by the ultrasonic sound waves, even the most delicate wires are unharmed.

NEW: *Acoustica's fully transistorized "20-KC" line of ultrasonic cleaning systems brings new speed and efficiency to your production cleaning operations. Available in standard sizes from 3 to 6 gallons; special systems up to 500-gallon capacity. (Illustrated: 3-gallon SC-252 System.) Acoustica also offers a complete line of standard 40-KC cleaning systems.*

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where: Yi = a drift reading at any position,

Tj = the sum of the drift readings at a position,

n = the number of drift readings at each position, and

N = the total number of drift readings.

The standard deviation of the calculated drift coefficients may be shown to be:

(1) Bias: $\sigma d_0 = \frac{\sigma e}{\sqrt{n}}$ degrees per hour, and

(2) $\pm \sigma (d_1, d_2, d_3, d_4)$ degrees per hour (for 30° increments) $= 2 \sigma d_0$.

An estimate of the error in fitting the data plot to the drift rate formula mentioned above with the limited number of Fourier Series terms used may be obtained by the following.

Residual Sigma:

$$\pm \sigma r = \sqrt{\frac{\Sigma (y_i - y_j)^2}{\frac{N}{n} - 1}} \text{ degrees per hour}$$

where: y_i = magnitude of fitted curve at a position, and

y_j = average of the drift readings at a position.

- **Significance of tests**—Through the use of these techniques for determining and processing data, Lear believes that drift rates can be accurately determined.

Improvement over methods used previously is assured, since the gyro is tested in the same manner as ultimately used. Moreover, the tests permit covering a wider range of acceleration direction relative to the gyro than through conventional test procedures.

The tests do not employ Scorsby motion or "concrete pilings" in tests, because the company feels that resulting impact conditions do not simulate the variety of forces experienced in an actual missile in-flight environment.

Although they are being employed on several classified programs, it can be said that these tests have been used on high-performance, ground-to-air missiles now under development. These impose conditions of severe vibration and sustained acceleration on the missile born gyros, tending to contribute heavily to the drift problem.

- **Advantages**—Lear feels that it has proven that employing these techniques eliminates unexpected drift from new gyros—so that performance can be satisfactorily predicted.

A major advantage lies in the fact that identical results can be obtained prior to missile installation with the bench tests described—or compared with those obtained from actual firings. ⌗

—expansions—

NORAIR DIVISION, Northrop Corp. has officially opened its new advanced research center in Hawthorne, Calif.

MARSHALL INDUSTRIES, INC. of San Marino, Calif. has formed a new subsidiary, Marshall Laboratories, for development and manufacture of electronic equipment. Stuart Baker, formerly with Space Technology Laboratories, heads the new firm. The Marshall subsidiary will be located in Torrance, Calif.

ELECTRO-OPTICAL SYSTEMS has formed an Advanced Power Systems Division for research and development in basic energy conversion and application of such activity to advanced power systems.

INTERNATIONAL RECTIFIER CORP. has combined forces in Italy with Piemontese Sviluppo Industriale S.P.A. to form a projected multimillion-dollar semiconductor manufacturing facility on the European continent. A new 16,000-sq.-ft. facility at Turin, Italy, will house the initial venture. Production is scheduled for April, 1961.

COMMUNICATIONS ELECTRONICS, INC. has been organized by four former employees of Nems-Clarke Co., Division of Vitro Corp. of America. John F. Whitehead, former sales director for Nems-Clarke, is president of the new company, which has taken offices at Bethesda, Md. Ralph E. Grimm, Paul R. Mattix, Jr. and Edward M. Gearing are executive vice president, vice president and secretary-treasurer respectively.

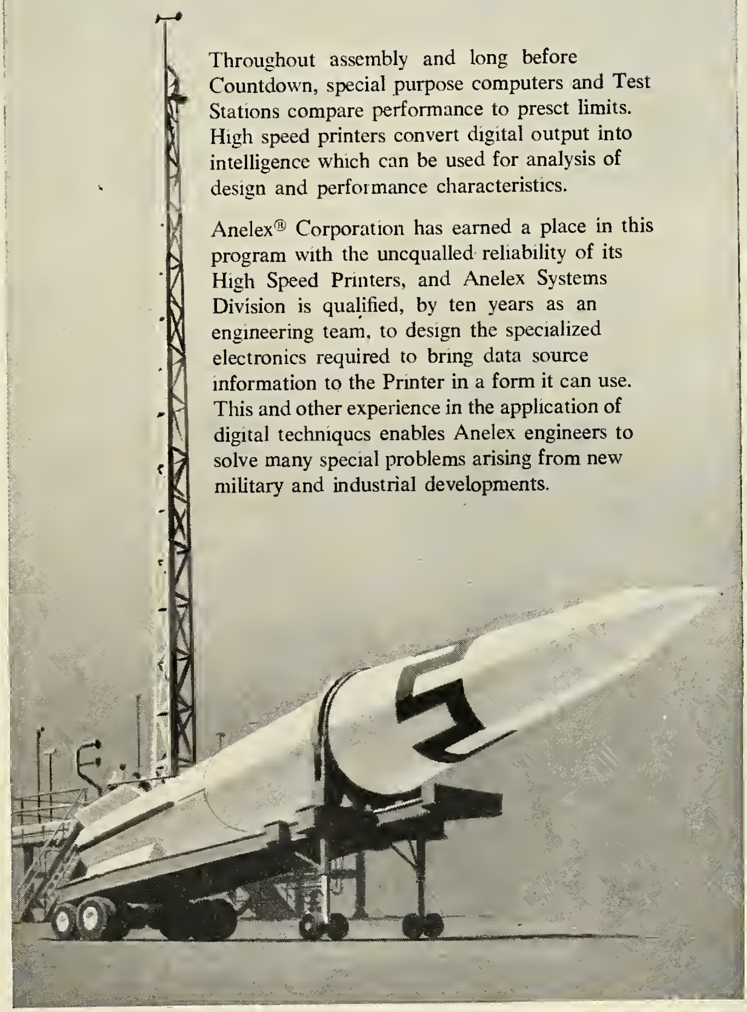
APPLIED ELECTRONICS CORP. has established a West Coast office in Santa Monica, Calif. Lawrence Hermes has been named vice president in charge of the West Coast Division. He is former vice president of General Devices Inc. of Princeton, N.J., and recently has become president of the International Communications Corp., also in Santa Monica.

financial

Airwork Corp.—Sales for the year ending July 31 topped FY 1959 by some 25% at $12.5 million. Net income reached $420,688, compared with the $259,018 earned in 1959.

Litton Industries—Earnings of $7.5 million for the year ended July 31 compared to $4.96 million in FY 1959. Sales amounted to $187.8 million, as compared to 1959 sales of $125.6 million.

Long Before Countdown...



Throughout assembly and long before Countdown, special purpose computers and Test Stations compare performance to preset limits. High speed printers convert digital output into intelligence which can be used for analysis of design and performance characteristics.

Anelex® Corporation has earned a place in this program with the unequalled reliability of its High Speed Printers, and Anelex Systems Division is qualified, by ten years as an engineering team, to design the specialized electronics required to bring data source information to the Printer in a form it can use. This and other experience in the application of digital techniques enables Anelex engineers to solve many special problems arising from new military and industrial developments.

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BULLETIN FROM BOEING...

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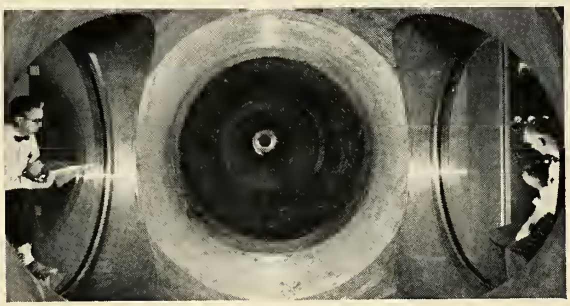
Minuteman, the nation's first solid-fuel ICBM, blasts from underground silo, left, in tethered firing test. Successful Minuteman firings cut test program, saving millions of defense dollars. Boeing is weapon-system integrator of the 6000-mile-range Minuteman missile, now under development.

FLYING COUSINS. You can cross a continent or an ocean in brief hours by Boeing jetliner, then fly to local airport or center-city in a helicopter built by Boeing's Vertol Division. Vertol helicopters are flown by the U.S. Air Force, Army and Navy as well as by the commercial carriers and armed services in many countries. Boeing 707s and 720s—most proved jetliners in the world—have already carried more than 10,000,000 passengers.



HOTSHOT TUNNEL. Here, in largest privately owned wind tunnel facilities in the world, future aircraft, missile and space-vehicle models can be tested at speeds up to 18,000 miles an hour. Many space-flight conditions can be simulated during tests. Decades of emphasis on research have enabled Boeing to pioneer nation-benefiting advances in vital areas of manned and unmanned flight.

SEAGOING TURBINES. Boeing gas-turbine engines power this high-speed oil company personnel boat as well as U.S. Navy minesweeping launches and landing craft. Light, powerful, compact Boeing shaft-drive turbines have scored many firsts: first turbine to power highway truck, fire engine, helicopter, locomotive and light airplane. Boeing turbines also serve in jet-engine starters used by U.S. Air Force and commercial airlines.

BOEING

JET AIRCRAFT, MISSILES, HELICOPTERS, TURBINES, WEAPON-SYSTEM MANAGEMENT, SPACE-FLIGHT VEHICLES AND SYSTEMS.

If Cold War continues . . .

$49 Billion DOD Budget Seen by '70

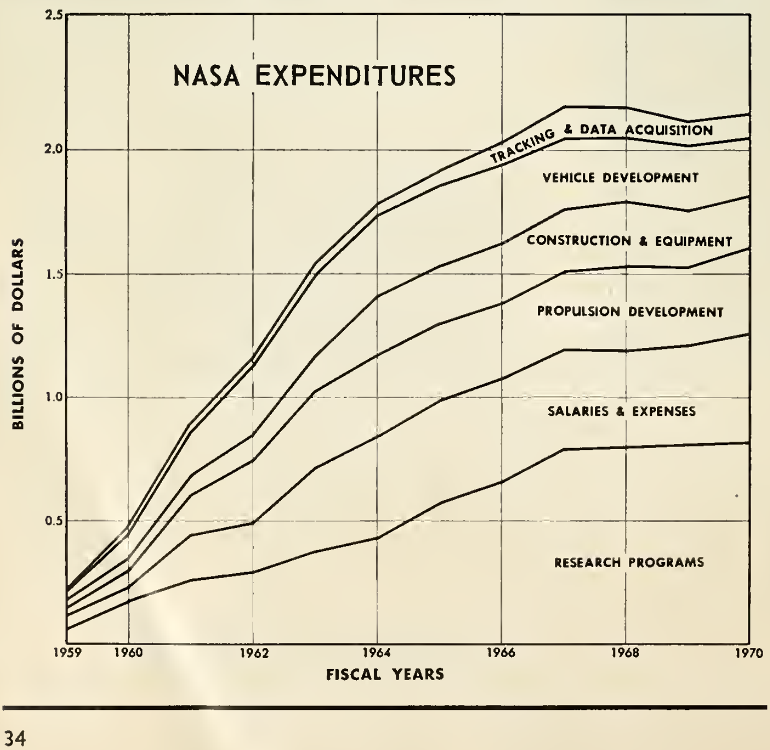
- DOD expenditures are estimated to rise at a slower rate than the GNP, from $41 billion in 1950 to $49 billion in 1970.
- Within the military budget, R&D is expected to continue receiving an increasing share of the total. Overall: approximately one-half of the military budget is likely to be devoted to procurement of hard goods.
- Shift in AF procurement from aircraft to missiles and astronautics is expected to continue with a "cross-over" in 1963. Thereafter missiles and astronautics will dominate
- Expenditures for ships and subs will again replace aircraft as main element of Navy budget in the '60's.
- Army expenditures are likely to continue at presen low levels with the bulk of funds devoted to tactical an defense missiles
- NASA expenditures are estimated to rise from les than $500 million in 1960 to $2.2 billion by 1967 an level off as existing programs phase out.

MUCH HIGHER defense spending may be anticipated under the new administration, but a Boeing Airplane Co. economist predicts that actual DOD budgets will rise on a steady line to about $49 billion by 1970.

Dr. Murray L. Weidenbaum bases his forecast on the growth pattern established during the past decade. Although there has been much comparing of military spending to the percentage of Gross National Product, Weidenbaum believes it is unrealistic to base any projection on set figures. For outlays in percent years have shrunk percentagewise in relation to the GNP.

Over the next 10 years, barring any radical change in the international political climate, the Boeing economist sees more money being pumped into the military as the result of sudden crises. But these bulges will be offset by inevitable economy drives.

Defense spending has been rising absolutely—but on a declining percentage of GNP and the Federal budget. It would seem reasonable, therefore, to base estimates of future market potential on a continuation of this trend.



• Military market analyzed—A analysis of the military market mus proceed on the basis that it is vastl different from the consumer market Four factors make it unique:

The military market . . .

–Has doubled in the past decad alone.

–Is the customer for one-third of al capital goods produced.

–Is the customer for one-half of al industrial R&D.

–Is a one-customer market.

The following analysis of the military market is:

–A projection of the over-all leve of economic activity.

–A projection of the military budge on the basis of the economic forecast and

–An analysis of the composition o the military budget.

The long-term ability of a nation t sustain a defense effort depends on th growth of the economy and the shar devoted to military needs. Hence, th economic forecast is the starting poin for our analysis.

Four strategic factors will be operating in the 1960-1970 period to stimulate economic growth: a rapidly expanding population, a very substantia increase in the average standard of living, an unprecedented rate of ne product introduction, and an expansio of governmental non-defense programs

The massive wave of research an development projects in the decade o the 1950's is a tremendous force fo future change in the national economy Commercialization of major technological advances in military and spac programs undoubtedly will continue However, these may take the forn mainly of utilization of the ne methods and processes developed rathe

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THE MISSILE/SPACE WEEKLY

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han merely adaptations of the military nd-products. Our analysis, on the basis f these factors, yields a Gross National roduct of approximately $700 billion n 1970, which is well within the range f estimates prepared by other comanies and by various research instituions.

• **Military spending level** — The verall level of military expenditures is rojected on the assumption that the urrent state of international tensions—he Cold War—will continue, that no fringe" wars will develop involving J.S. military forces, and that a workble disarmament program will not be dopted during the 1960's.

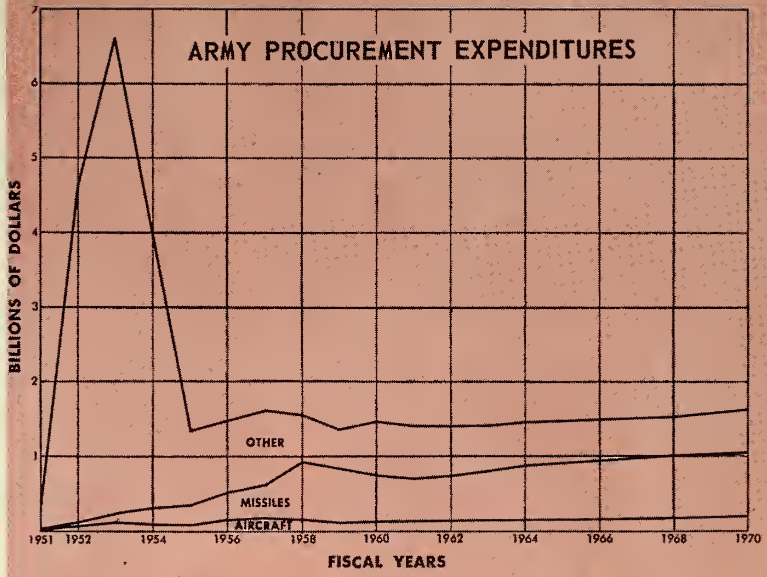
It is anticipated that the 1960's will ee the occurrence of international incilents resulting in increases in defense pending. Likewise, "economy" drives re likely to occur from time to time. The net result of these opposing—and ssentially unpredictable—forces is a low, upward long-term trend in defense pending.

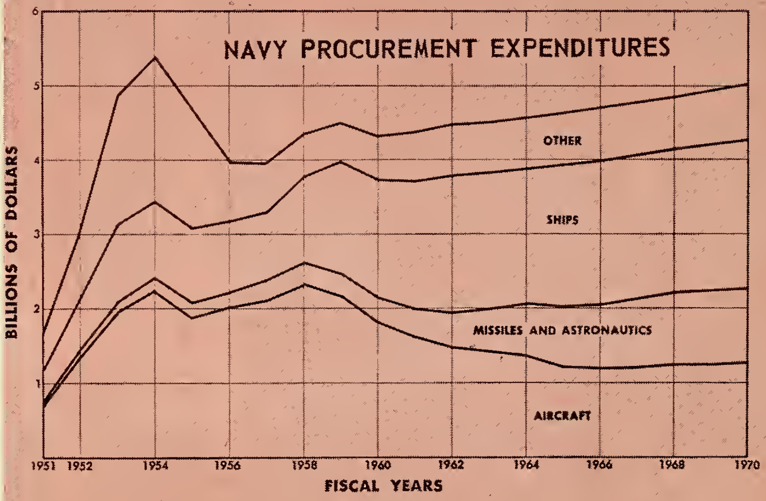
The composition of current and lanned military programs indicates that he proportion of procurement and ther "capital" expenditures will mainain the current share of about one-half he military budget. Some small further eductions are projected in the operatng categories, mainly as a result of the ontinued declines in the numbers of nilitary personnel. The R&D category s expected to rise as a result of the roportionately larger development vork on missile and space programs.

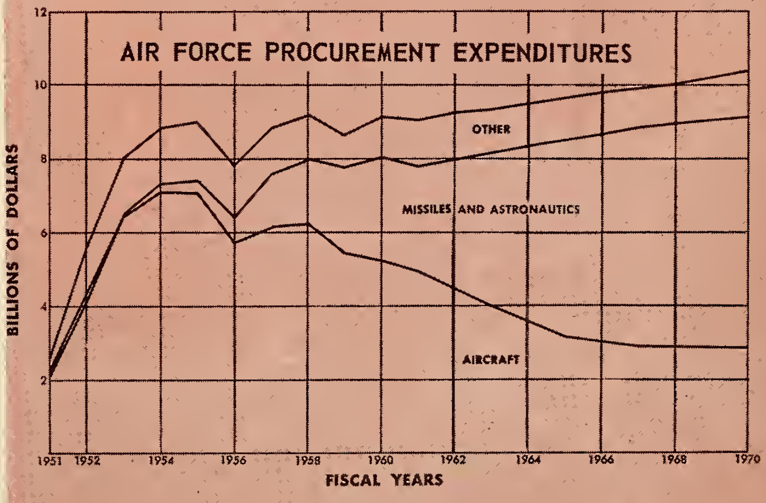
• **Trend of procurement outlays**—ircraft and missiles account for aproximately 70% of total military prourement expenditures at the present ime, and dominate the procurement udgets of the individual services. Three najor procurement categories—aircraft, nissiles, electronics—account for 80% f total military expenditures. The renaining procurement funds are divided mong ships, trucks, artillery, rifles, and ther traditional Army and Navy veapons.

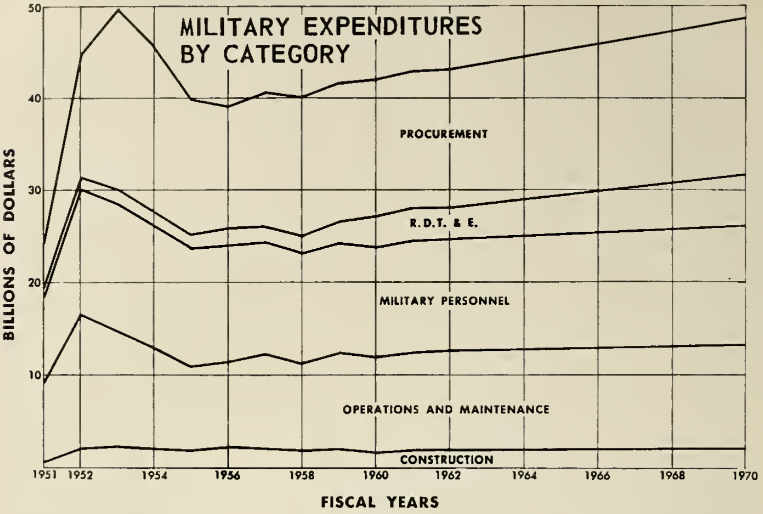
Except for ships (which includes ubmarines), each of these items has hown a major decline in recent years s a result of the shift from convenonal equipment to advanced air and pace weapon systems.

• **AF expenditures** — Procurement y the Air Force has been one of the astest growing segments of the military udget. It is anticipated that the overll category will continue to rise, but nat major changes will occur in the omposition of programs. Aircraft exenditures dominated AF procurement uring the entire 1950's. This trend is xpected to reverse about 1963, when xpenditures for missiles and astronaucs are expected to exceed total aircraft roduction outlays.









The missiles and astronautics category covers such weapons as ballistic missiles and satellites and other operational military space programs. The space systems may cover such programs as a *Dyna-Soar* type reconnaissance and bombardment vehicle plus a later lunar exploration program sponsored by NASA and financed by AF funds. A series of communications satellites is also likely.

It is expected that aircraft will require approximately one-fourth of AF funds in the 1960's. Some of the strategic programs—such as the B-52, the B-58, and the KC-135—are expected to continue until the middle of the decade. The available funds indicated on the chart could cover a new tactical fighter-bomber, at least limited quantities of a B-70 or other advanced supersonic bomber, and modernization of the MATS fleet with jet equipment.

The "other" procurement category includes outlays for SAGE, DEW, BMEWS, and related support programs.

• **Navy expenditures**—Procurement by the Navy is expected to continue the post-Korean rise, reaching an annual level of $5 billion by 1970. The major change envisioned is a shift in expenditures from aircraft, which was the largest naval procurement category in the 1950's, to ships which are expected to account for almost half of production funds by 1970.

The projected increases in the ship category cover accelerated construction of *Polaris* submarines, ASW craft, and guided missile ships. Increases for missiles and astronautics also result largely from the *Polaris* program and a follow-on. The Navy is also expected to make significant expenditures for astronautics, in its assigned area of navigation satellites.

The projected reduction in Navy aircraft procurement results from the redirection of emphasis to air-carried missiles rather than high performance aircraft for offensive, defensive, and ground support missions.

Other Navy procurement expenditures cover improvements in world-wide communications, ASW support, and other electronics equipment.

• **Army expenditures**—The major development in Army procurement expenditures occurred with the termination of the Korean War; the expenditure level of over $6 billion in 1953 was reduced to under $2 billion by 1955. In more recent years, Army expenditures have shown some fluctuation but give no evidence of the growth trends apparent in AF and Navy procurement. Only a very slight projected increase in Army procurement outlays in the 1960's appears likely, with the annual total still under $2 billion by 1970.

In recent years, missile expenditures have dominated the Army budget. This relationship is expected to continue with field missile programs competing with *Nike* and other air defense programs for Army procurement funds.

Army aviation, although growing, is not expected to reach the $200 million annual level until after 1970. Army aircraft are expected to continue to perform primarily utility, reconnaissance, and close support logistics functions. "Other" Army procurement includes electronics systems and ground mobility items.

• **Research and development trends**—By its very nature, military R&D is directed toward new weapon systems and related military purposes. The greater part of the expenditures is devoted to military weapons—aircraft missiles, ships and, increasingly, space vehicles. As shown in the chart, the missile category has been dominant in recent years and the space category has come into its own. The cross-over between missiles and aircraft occurred in the early 1950's and the cross-over between space and aircraft is occurring now—a harbinger of trends in procurement in the 1960's.

It is estimated that about one-fourth of military R&D is devoted to "research"; three-fourths of the funds are devoted to the development of weapon systems. The amount devoted to basic research comes to a little over $100 million a year.

• **NASA budget** — Civilian space expenditures are not a part of military expenditures, but are budgeted separately. NASA has the responsibility for the scientific investigation of space for civilian applications. Total NASA expenditures through 1970, on a cumulative basis, are estimated to be $17½ billion, mainly for large booster programs such as *Saturn* and *Nova,* plus vehicle and payload development.

Research programs include all basic research and expenditures for manned space flight, meteorological satellites, interplanetary probes, lunar unmanned explorations, scientific earth satellites communications satellites, sounding rockets and space rendezvous techniques.

Propulsion development includes al expenditures for solid and liquid fue engines, and nuclear, ion and plasma propulsion systems. Vehicle development covers the development of the *Saturn, Nova,* and *Nova* follow-on *(Arago)* boosters, exclusive of engines Tracking and data acquisition includes all expenditures for the maintenance and operation for tracking and data handling facilities.

Salaries and expense represent approximately 25% of NASA expenditures each year through 1970. This category includes all outlays for the construction and operation of NASA facilities, the procurement of equipment and all personnel costs.

• **Trends rather than specifics**—Projections such as these are designed to convey ideas of future trends and relationships and to provide general orders of magnitude, rather than to forecast specific values for individual years Analyses of the military market may provide important background information for management decisions on product lines, research and sales efforts, and investment programs. However, the utilization of market research data is a function in good measure of management's acceptance of and confidence in the market research activity. ‡

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AF Hoping for 'Cheap' SAINT

- ***Heavy reliance foreseen on existing hardware; may use Atlas***
- ***First details of Norair's plan***
- ***'Parking' orbit may be one way to intercept enemy satellites***

by Frank McGuire

Los Angeles—The Air Force appears to be hoping this week that the Missile/Space Industry can turn out *Saint*—the secret anti-satellite system—as cheaply as possible.

As the Ballistic Missile Division moved toward a decision on award of a development contract, informed sources made clear that the Air Force sought to cut as many corners as possible by capitalizing on other programs and using much existing hardware.

Some of this hardware is understood to include Convair's *Atlas* and Lockheed's *Agena B*, as well as a variety of already designed sensors that might be improved.

• **Delicate mission**—*Saint*, short for "satellite inspection technique," consists of two phases, inspection and destruct, with the same contractor not necessarily responsible for both. The destruct phase is considered relatively easy compared with the extremely difficult task of rendezvous and inspection.

Proper determination of the suspect satellite's mission is extremely important, since a wrong guess could send a scientific payload to destruction and trigger an unnecessary international incident.

The Air Force is currently seeking ways to determine the mission of a satellite, discriminate between decoys and live payloads, and also to discriminate between scientific and military payloads which may have some similarities.

Most likely way of accomplishing these ends, informed sources say, is to measure the mass of a satellite and determine what kind of electronic activity, if any, it is engaged in. A small mass would indicate a decoy, while a massive, passive payload might indicate an orbital weapon awaiting a signal from ground stations. At present, no instrument is believed available which can specifically measure mass at any distance.

• **Much already done**—The *Saint* program will be a continuing one, with improvements cranked in as soon as they become available. AFBMD is reported readying a shot in the *Discoverer* program to check out rendezvous techniques within the next few months. About 20 satellite vehicles are reportedly required initially for the *Saint* program.

Saint will undoubtedly use already existing techniques for the rendezvous phase of its mission. These techniques, required for any type of vehicle rendezvous in space, have been worked out by a number of companies now in the satellite research field.

Considerable work in this area has been carried out by Norair's Astro Systems and Research Laboratories in Hawthorne, Calif. Dr. Geza S. Gedeon, head of the Astrodynamics lab at the Northrop facility, worked out the necessary trajectories in connection with other programs, but they are applicable to *Saint*.

Numerous categories of satellite rendezvous techniques exist, depending on the parameters set up for the operation. The intercepting satellite, ("intercepting" used in its broader sense) can be powered by a low-thrust engine operating continuously, or it can be unpowered and operate ballistically.

Additionally, it can be launched from the surface of the earth in a point-to-point rendezvous or it can placed into a parking orbit in the san plane as the target satellite ("targe also used in the broad sense), the alter velocity to assume the same al tude and a rendezvous.

Still again, the intercepting satelli can achieve a co-linear rendezvous if is launched into the plane of the targ satellite, and velocities are then alter appropriately to complete the maneuve

• **'Parking' advantages**—Parkin orbits are generally most favorabl time permitting, due to the less stri gent requirements on launch tim Parking orbits are usually closer to t earth than the orbit of the target sat lite, with acceleration bringing the i tercepting payload up to proper altitud

In cases where the target is in t lowest possible circular orbit, the i terceptor can be placed in a high parking orbit, then use retro thrust drop out of this orbit and onto t target. There it matches velocity, pla and altitude for inspection purpos and possible destruction.

The parking orbit has the advanta of using ground-computed optimizati techniques to cut down fuel useage a avoid great angular or velocity chang from the initial track. The particul conditions affecting the situation at a given time can be considered befo the actual rendezvous operation begi

• **'Parking' trouble**—However, t disadvantage of a parking orbit principally one of time. When elaps time is a vital element in a rendezvo it may well be desirable to plan a poi to-point intercept directly from t earth's surface. This method is wast ful of fuel and often requires extren angular change, but just as often sav time and is favorable when peculi orbit considerations make the parki orbit method impractical. Point inte ception is applicable when only tv maneuvers are allowable.

Aircraft-launched satellite inte ceptors are not considered feasible, d to the relatively low velocities gene ally obtained by such methods. T B-70 may perhaps change this situ tion (M/R, Aug. 29, p. 13), but ai craft-launched satellite interceptors a not seen possible with what is cu rently available, and the B-70 is f from currently available.

The coplanar rendezvous requir that the intercepting trajectory be

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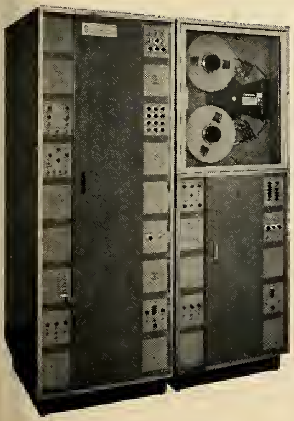

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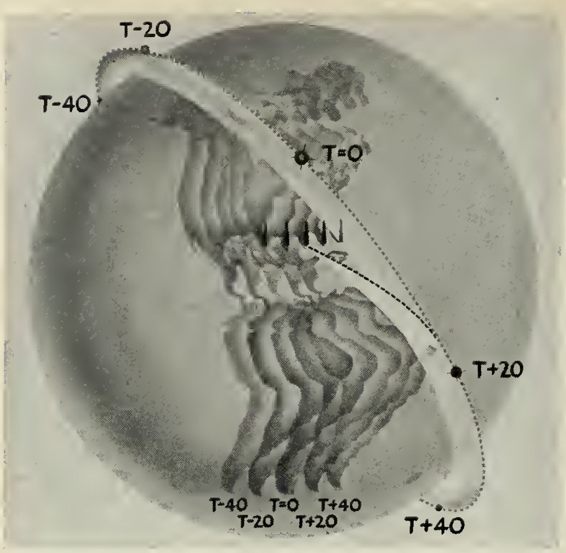
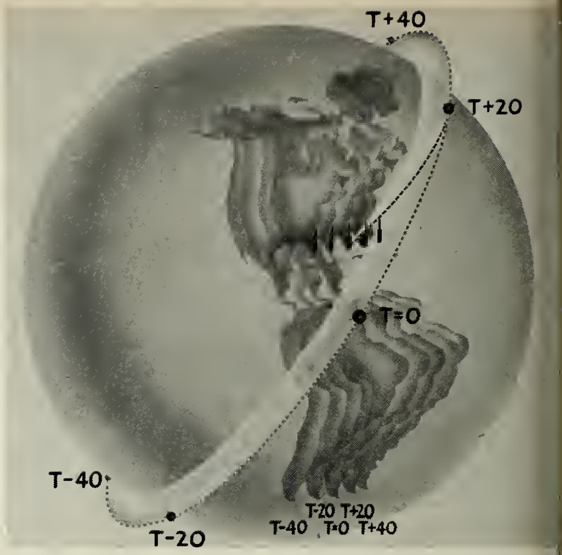


POINT INTERCEPTION of a satellite in a north-to-south track.



POINT INTERCEPTION of a satellite in a south-to-north track.

the same plane as the target orbit before the terminal maneuver is begun. Four maneuvers are needed in such a coplanar intercept when the interceptor is surface-launched: boost launch into an arbitrary plane; change of plane at a nodal point with the target plane, then injection into a coplanar parking orbit; take-off from this parking orbit into a transfer orbit which intercepts the target and, finally, the terminal homing maneuver.

For a coplanar interception from an already established parking orbit, only the last three maneuvers are required.

Co-linear interception requires merely velocity changes, which are made during maneuvers, with the stipulation that the launch from the earth be made into the same plane as the target satellite. Subsequently, a co-tangential transfer orbit is made, and finally the velocity of the interceptor is increased to the level of the target's velocity.

Again, when executed from an established parking orbit, the co-linear rendezvous requires only the last two maneuvers, due to the requirement that the "waiting" orbit must be coplanar with the target for this type of mission.

(Research conducted at Grumman Aircraft Engineering Corp. indicates that the transfer requiring least fuel between coplanar orbits is carried out by means of two tangential impulses, only when the terminals have zero radial velocities. In this case, the Hohman transfer between circular orbits is best.)

• **Saving not worth it**—Co-tangential transfer between elliptic orbits, though not a minimum fuel transfer method, is almost optimum for small eccentricity orbits. "In the case of satellite rendezvous, where the orbits will be very nearly circular, the extreme complexity of the rigorous optimum solution can hardly be justified by the insignificant amount of fuel saved," Dr. Gedeon said.

The three principal methods of satellite rendezvous have modifications, including changes of plane in several steps, multi-parking orbits, dog-legging during boost, and other alterations. These, however, depend on peculiar restrictions of the situation, such as limited firing azimuth.

Overall optimization of the entire rendezvous operation would require simultaneous optimization of all phases. Since the powered flight trajectories, as pointed out, must be substituted by zero-length instantaneous velocity changes or by the burnout conditions to overcome the mathematical problems involved in the rendezvous, the phases cannot all be optimized simultaneously with the preliminary and ballistic phases.

Individual optimization and subsequent establishment of interface consistency is feasible, however. This will not provide the overall optimum, but it is unlikely that any great deviation will result.

• **How to choose**—According to Dr. Gedeon, the parameter to be optimized is either fuel or time. In the case of point-to-point rendezvous, the fuel should be optimized, since only two maneuvers are permitted in such a trajectory. The shortest time would be achieved by launching at the highest possible velocity immediately at the arbitrary initial time previously chosen, but this would result in such impractical circumstances as rendezvous from a head-on meeting, fuel requirements several times the launch weight, o other intolerable parameters.

From his calculations, Dr. Gedeon has established certain conclusions, indicating the methods most applicable to various situations:

–For plain interception, a two-maneuver, point-to-point method is recommended. Fuel requirements should be optimized by finding the optimum launch and arrival time.

–For rendezvous, both the point interception and a four-maneuver co-linear interception technique is recommended. In the first case the fuel should be optimized by finding the optimum launch and arrival times. In the second case, time should be minimized by finding the optimum parking orbit altitude and shape.

–The boost phase has to be substituted by individually optimized burnout conditions and interface compatibility between the phases will be achieved by an integration procedure.⌘

B-70 Flight Simulation Facilities Near Completion

A $7.7-million addition to the ground test facilities at Wright Air Development Division, ARDC, will be used to check out the flight stresses and temperature effects on full scale B-70 bombers and *Dyna-Soar* space vehicles.

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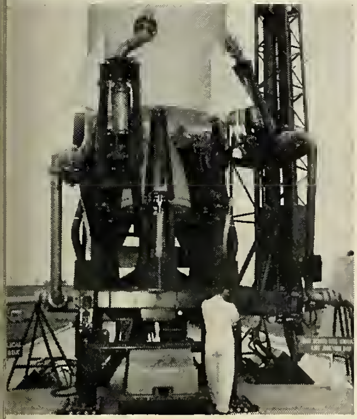
3M Materials Memo

News of materials for the aerospace industry—selected from the 27,000 products of the 3M Company



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When facing most crises, a stiff upper lip can be a real asset. Of course, if the lip in question happens to be a seal in a cryogenic fuel system, you'd probably give anything to keep stiffness out of the picture. One way to do just that with confidence is make these critical seals of "Kel-F" Brand Halofluorocarbon Plastic. This remarkable polymer has actually retained a good degree of flexibility at the liquid hydrogen temperature of −432°F – where ordinary seal materials become so rigid they shatter.

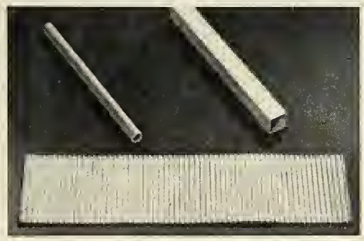
"Kel-F" Plastic has a number of welcome surprises bound up in its tough little chain. Not the least of these is its chemical inertness. This not only gives it resistance to corrosive chemicals and aggressive organic solvents, but in combination with its low temperature properties makes it a safe playmate for liquid oxygen. Other phases of its agreeable personality include good impact and compression strength and resistance to cold flow. What's more, it's a snap to polish or machine to required dimensions.

Why not get more information on this cool performer by contacting your Chemical Division representative or checking the box below.

For High Calorie Diets

Calories running rampant can scuttle a sylph-like figure in short order. In the form of heat, they can be pretty damaging to electrical insulation, too. Of course, if that insulation is our Mica Insulator Division's "Isomica" 6-T, you're in for a pleasant surprise. You'll find that its voracious appetite for heat puts even the legend of the salamander's fiery diet to shame. It takes exposure to temperatures as high as 1900°F for short periods right in its stride. In environments running continuously at 1500°F, it literally thrives, without any degradation in electrical properties.

"Isomica" 6-T can boast a pretty exclusive ancestry. Its basis is a continuous 100% pure, crystalline mica sheet. This then is impregnated with an inorganic binder which gives it rigidity and strength – and incidentally, through chemical reaction, higher temperature resistance than the original mica. The final product in tubular form of varying sizes (3/8" to 1 1/8" O.D.) offers an extremely uniform high dielectric strength – approximately 650 volts/mill for 1/16" wall. Arc resistance is so high that the standard ASTM test goes off scale. It's also been approved for use where resistance to gamma radiation is required.



Experimental quantities of 6-T materials have also been made in rigid flat sheets and corrugated forms which can be flexed parallel to the corrugation.

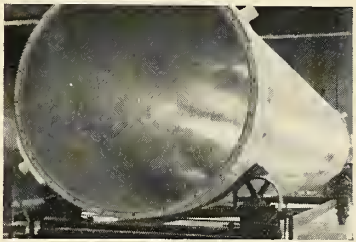
We think 6-T is a pretty hot number for coil forms, resistor and transformer cores, heating element spacers and scads of other uses. Check the coupon below for more information and see if you don't agree.

Bird Under Glass

A delicate delight for an epicure's palate? Well, hardly. The bird in this case is the Polaris IRBM – and the case, which is the whole point of our little dissertation, a tough *glass* reinforced plastic shipping container.

Built by our subsidiary, the Zenith Plastics Company, it's the largest one piece reinforced plastic cylinder ever fabricated. More than 25 feet long with a 57 inch I.D. and weighing less than 2400 lbs., it offered a significant weight reduction (with equivalent strength) over the metal case is replaced. In case you're wondering, ovality and straightness tolerance throughout the cylinder were less than ±.015". In addition the structure included an integral electric heating element for environmental control.

The Polaris case is an excellent example of the kind of structural magic that can be worked when the right materials and fabrication technology are combined in one facility. The raw materials, 3M's "Scotchply" unidirectional filament systems, assure top uniformity in composition and an excellent strength to weight ratio. Zenith, a fabricator (of many years standing) of large precision structures, is now even better equipped to provide quick, versatile and reliable service for you. Through expansion of their facilities and refinement of techniques, they're able to produce even larger such units – either as cylinders or complete rocket motor cases, and do so economically. Even if your requirement is a bit "offbeat," don't be afraid to discuss it with them. Chances are pretty good that they've already had worse. For current data on facilities and capabilities, check the box below.



3M Company, Missile Industry Liaison—Dept. VAB-110
St. Paul 6, Minn.

Please send more information on ☐ "Kel-F" Plastic
☐ "Isomica" 6-T ☐ Zenith Plastics
☐ 3M Products of the Aerospace Age.

Name______________________________

Firm______________________________

Address______________________________

City________________Zone______State__________

"KEL-F," "ISOMICA" AND "SCOTCHPLY" ARE REGISTERED TRADEMARKS OF 3M CO., ST. PAUL 6, MINN.
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Explorer VIII Probes Ionosphere

Data transmitted will aid in designing nuclear and ion rockets and tell more about radio wave performance

THE *EXPLORER VIII* ionosphere measurements satellite will provide extensive data needed for advanced communications experiments and for the design of nuclear and ion rockets.

The 90-lb. satellite, launched into an elliptic orbit early Nov. 3 by a *Juno II* vehicle, is expected to continue transmitting for two to three months. The orbit had an apogee of 1422.65 statute miles, a perigee of 258.44 statute miles and a period of 112.75 minutes.

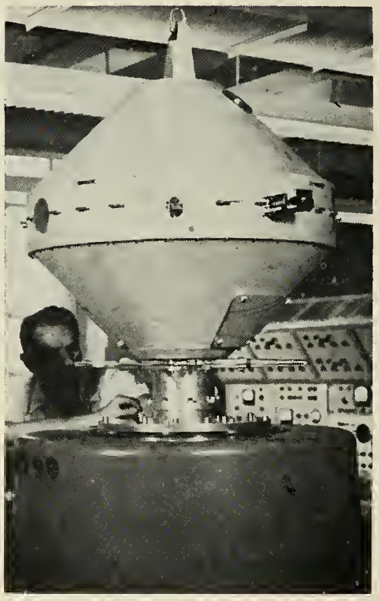
The National Aeronautics and Space Administration was trying for a nominal orbit of 1785 statute miles apogee and 245 statute miles perigee, and a period of 119.2 minutes.

• **Prelude**—Two hours after the shot from Cape Canaveral at 12:23 a. m. EST, NASA's Morton J. Stoller told newsmen the micrometeorite experiments aboard *Explorer VIII* are a necessary preliminary to solving the problem of dissipating heat from nuclear and ion rockets in space. The advanced rockets will be cooled by radiators, whose design will be controlled by the structure necessary to protect it from micrometeorites.

The ionospheric measurements will provide direct information that will add detail and check inferences on how radio waves are carried around the earth. This information will help communications experts choose frequencies for long-distance communications. Until now, ionosphere information has been inferred from radio propagation characteristics.

The spacecraft carries eight experiments, mostly for measuring positive ion and electron composition of the ionosphere. It is powered entirely by batteries. Thus there is no problem of turning off the transmitters when information is no longer needed. Without solar cells to recharge the batteries, they are bound to go dead.

• **Comparatively costly**—*Explorer VIII* is the third space success for *Juno II*, developed by NASA's Marshall Space Flight Center (when it was part of the Army Ballistic Missile Agency) as an early booster vehicle. However, the vehicle will phase out after two or three more shots because of its relatively high cost per pound of payload in orbit.



EXPLORER VIII is given a vibration test at the Marshall Space Flight Center in Huntsville in preparation for launching.

Stoller figured a cost of $2½ to $3 million for a *Juno II*, including part but not all of the launching expense and field support. This compares with an expected cost of about $1 million for the all-solid *Scout*, when it goes operational and is handled completely by the prime contractor, Chance Vought, within a year or so. The *Scout* has about the same or slightly greater payload capacity.

Juno is more expensive primarily because it uses a modified *Jupiter*, with a liquid-propellant engine, as first stage. The upper three stages are clusters of 11 and three and a single scaled-down *Sergeant* rocket developed by Jet Propulsion Laboratory.

Explorer VIII carries these experiments:

–Radio frequency impedance probe, a dipole antenna with arms 10 ft. long, which measures electrical capacitance o the sensor, which by comparison wit the sensor's free-space value gives in formation on electron concentratio surrounding the satellite.

–Single-grid ion trap, an arrange ment similar to the internal working of a radio tube, which collects varyin quantities of ions according to a gri voltage that varies between –5 an +25.

–Four multiple-grid ion traps, t provide information on positive io concentration and mass distribution a three points on the satellite equator an one at the upper cone near the spi axis, for comparison with data from th single trap on the upper cone.

–Langmuir probe, to measure elec tron temperature, a collector in th form of a circular plate insulated fro the satellite's aluminum skin, whic measures total diffusion current.

–Electric field meter, a rotating shutter type device that measures th static field due to the ion sheath tha forms around the satellite. Because o the high current drawn by the mete motor, it operates only on comman from ground stations and is programe to operate about six minutes for ever 100 minutes of orbit.

–Micrometeorite photomultiplier which transmits pulses resulting fro light energy given off as micromete orites hit the surface of an aluminum coated sensor.

–Micrometeorite microphone, whic measures frequency and momentum o impacts by converting the sound t telemetry signals.

–Four thermistors to provide tem perature readings.

All telemetry is on a real-time basis A single transmitter on 108 megacycle doubles for telemetry and tracking.

Stoller said the remaining *Juno I* shots will be S-45, an ionosphere bea con satellite, which contains radio fre quency transmitters for propagatio through the ionosphere, and S-15 which will measure the intensity an rough direction of gamma rays in th universe. A third *Juno II* is availabl as backup.

—reviews

OLARIS! THE CONCEPT AND CREATION F A NEW AND MIGHTY WEAPON, mes Baar and William Howard, Harcourt, ace and Co., New York, 245 pp., photoaphs, $4.50.

The first encounter of William Francis aborn, Jr., with the Navy occurred hen he met two midshipmen home on ave from Annapolis, showing off their ghtly cut white summer uniforms to the rm boys in Marlow, Oklahoma.

Raborn fell in love with the Navy and was a mutually happy affair which cared through the Naval Academy, flight aining, and into combat at Pearl Harbor nd World War II in the Pacific.

It still continues, mutually, with the klahoma boy now a vice admiral, fightg not the enemy but inertia blocking the ation's newest strategic weapon.

"Polaris!" by James Baar and William loward, both editors of Missiles and ockets Magazine, is as much the story f the carrot-topped Raborn as it is the ory of the first U.S. ballistic missile to be red from a submerged submarine.

From the beginning, when it started as sea-going version of the old liquideled Army *Jupiter*, the Navy's deterined plan to join the U.S. strategic forces as beset with difficulties.

The *Jupiter* was too big, too dangerus, too uncertain, too everything—but aborn tried his best to make it work. hen solid fuel came along, and Raborn ade the dangerous switch on which ested the success of the program as well s the future of Raborn himself.

There is the story of the fight for unds, of adopting the new missile to the lso new atomic submarine, of Admiral ickover, Mr. Atomic Submarine, himself. aar and Howard carry you through the itter disappointments of failures, the rials and errors, the fight against time, he opposition of the other services, the ethargy of the Administration, the nevernding battle for funding; through the rst five launching failures and the final ictory of pure determination.

If the book has one main theme it is o point up clearly and relentlessly that eveloping new techniques, new metals nd new fuels for a new weapon system re not the main problems.

The great frustrations which drive men f action half crazy are the indecisions of he men who have the power to delay, to old up funds, to vacillate month after ong month—these are the main factors. uick and firm decisions at the right time hould have given us a fleet of *Polaris*-quipped subs more than a year ahead of me the nation will now have them.

Polaris! is written largely from a Navy iewpoint; some readers will find in it a ias in the Navy's direction. Some of the otivations and some of the decisions are ecessarily oversimplified. But Polaris! will e recognized as the record of a heroic chievement. The authors have succeeded, rough interviews, anecdotes, flashbacks nd an incredible amount of research in aking Polaris! a valuable addition to the avy's recorded history—C. N.

HANDBOOK OF LAPLACE TRANSFORMATION: TABLES AND EXAMPLES, Floyd E. Nixon, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 115 pp., $6.00.

This little book is an excellent "How to Do It" for the engineer having to solve linear differential equations. The mathematics is simple—a standard course in calculus being all that is needed—, and the presentation is tutorial. A reasonably backward technical student with ambition to apply Laplace transformations, will with the aid of this book be able to do so within an hour.

MECHANICAL PROPERTIES OF SELECTED ALLOYS AT ELEVATED TEMPERATURES (PART II: DESIGN CRITERIA OF SILICON CARBIDE), H. A. Pearl and others, Order PB 161723 from Office Of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C., 134 pp., $2.75.

Nondestructive tests of silicon carbide were conducted to determine, in broad parameters, the areas where a brittle, nonmetallic body such as silicon carbide might be used in aircraft construction.

The tests were selected on the basis of usefulness in evaluating silicon carbide as an aircraft and missile leading-edge material. Included are manufacturer's property data for various types and forms of commercially available silicon carbide.

PROCEEDINGS OF THE SECOND CONFERENCE ON REACTIONS BETWEEN COMPLEX NUCLEI, held in Gatlinburg, Tenn., May 2-4, 1960, edited by A. Zucker, E. C. Halbert, and F. T. Howard, John Wiley & Sons, New York, 319 pp., $7.00.

The editors are to be congratulated for the speed with which they put between hardback covers the Conference papers, including a Russian one whose author was not permitted to deliver it personally. Presumably, there was State Department intervention in spite of the strenuous efforts of the conferees.

The editors see their volume as being of primary use to heavy-ion physicists and chemists as a "sort of status report of their field," and more generally to nuclear physicists interested in those aspects of their craft related to heavy ions. The book will also help the scientist "who finds himself at loose ends to evaluate the possibilities in this line (heavy ions) of research."

contracts

NASA

$114,815—**The Martin Co.,** Baltimore, for study of operational modes of the future second-generation *Saturn C-2* space vehicle.

NAVY

$9,400,000—**Federal Electric, subsidiary of IT&T,** for PMR range operations over the next three years.

$8,000,000—**Vitro Laboratories,** Silver Spring, Md., for coordination and testing of *Polaris* weapon systems on nuclear-powered submarines.

$5,500,000—**Yardney Electric Corp.,** New York City, for manufacturing Silvercel propulsion batteries for the experimental submarine "Albacore."

$1,775,000—**Northrop Corp's Radioplane Div.,** Van Nuys, for the production of 500 *KD2R-5* radio controlled aerial target drones.

AIR FORCE

The Whirlpool Corp., St. Joseph, Mich., for designing and building a space kitchen which would provide all foods and beverages required by 3 space pilots on a 14-day mission.

Lockheed-Brown Associates, Van Nuys, for production of improved shipping containers for the *Hound Dog* guidance system. Subcontract from **Autonetics Div. of North American Aviation.** Amount not disclosed.

Poly-Scientific Corp., Blacksburg, Va., for installing a reliability program for components for the *Titan*. Subcontract from **General Motors Corp's AC Spark Plug Division.** Amount not disclosed.

$1,775,000—**Northrop Corp.'s Radioplane Div.,** for *KD2R-5* aerial target, spare parts and data.

$1,399,033—**Sperry Rand Corp.,** Phoenix, for E4 automatic flight control system, spare parts and ground support equipment.

$1,150,853—**Goodyear Aircraft Corp.,** Akron, O., for additional contractor maintenance work and supplies for the TM76A *Mace* missile program.

$740,855—**Beckman Instruments, Inc.,** Fullerton, Calif., for 17 electronic units to be used with the *Minuteman* missile. Subcontract from **North American Aviation's Autonetics Division.**

$190,000—**General Dynamics Corp., General Atomic Div.,** San Diego, for development of a high-temperature thermionic converter for use in nuclear auxiliary power systems.

$160,000—**Space Electronics Corp.,** Glendale, Calif., for research investigation of ultra-low-frequency electromagnetic wave propagation.

$110,000—**University of California,** Berkeley, for continuation of research on "Chemical Effects of Radiation."

$79,994—**Cornell Aeronautical Laboratory, Inc.,** Buffalo, for research on "High Temperature Phenomena in Hypersonic Flows."

ARMY

$3,130,009—**Sperry Rand Corp.,** Salt Lake City, for research and development on the *Sergeant* missile system.

$903,000—**Ford Motor Co.,** Newport Beach, Calif., for design, development, test and demonstration of combat vehicle weapon system.

$900,000—**Sperry Rand Corp.,** Salt Lake City, for production engineering services for *Sergeant* missile system.

$800,000—**Sylvania Electric Products Inc., Electronic Defense Laboratories,** Mountain View, Calif., for fabrication of advanced radar equipment, scatter communication equipment and research covering the study of electromagnetic wave scattering (four contracts).

$218,025—**Reed and Shine Construction Co., Inc.,** Melbourne, Fla., for construction of electronic test shop systems at the Air Force Missile Test Center.

$176,856—**Raytheon Co.,** Waltham, Mass., for replenishment repair parts for the *Hawk*,

$99,983—**Firestone Tire and Rubber Co.,** Los Angeles, for engineering services for the *Corporal* missile and ground handling equipment.

$58,197—**Accessory Products Co., Div. of Textron, Inc.,** Whittier, Calif., for valves for *Nike* missile system.

Data Recorder Transducer Equalizer

The Tranqualizer, a transducer-equalizer manufactured and marketed by Data Instruments division of Telecomputing Corp. provides a method to receive and observe in real time, as well as to accurately record analog data otherwise masked and destroyed by the limitations of the measuring system.

Tranqualizer virtually eliminates undesirable ringing which results from the excitation of the transducer at or near the natural resonant frequency. It effectively extends the system's frequency response by several octaves, allowing a more accurate presentation of the stimulus function. Essentially an analog computer, the Tranqualizer performs by inserting into the data a complex transducer function which is the reciprocal of the transducer transfer function.

Circle No. 225 on Subscriber Service Card.

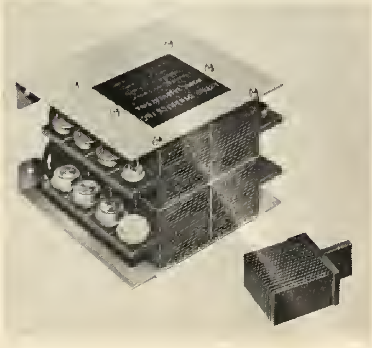
Single Component Epoxy

A 100% solids, epoxy, single-component coating for continuous operation up to 155°C is available from Columbia Technical Corp. HumiSeal Type 1F56 requires no mixing and may be used directly from the shipping container. Viscosity may be adjusted to yield build of 10 mils and thicker and the coating may be applied either by dip or brush.

Circle No. 226 on Subscriber Service Card.

Transistor Heat Sink

A modular aluminum sink has been introduced by Astro Dynamics, Inc. Model 2401 makes use of a light, compact, integrated blower and permits use of power transistors at 2 to 3 times previous achievable ratings. While dissipating almost 60 watts at 25°C, this heat sink has a thermal resistance between transistor shelf and air of less than 0.8°C/watt.



Through a high-pressure fin assembly process which produces a strong metal-to-metal bond and extremely high thermal conductivity, Astro Dynamics can vary size and spacing of fins to match specifically the requirements of a wide variety of systems and blowers.

Circle No. 227 on Subscriber Service Card.

High G Trimming Pots

Helipot Division of Beckman Instruments, Inc., has added two cermet models to its line of HELITRIM trimming potentiometers. Just released are Model 53, a unit with pins for printed circuitry, and Model 54, with solder lugs. They are virtually insensitive to vibration and can ride out 100 g's shock.

Circle No. 228 on Subscriber Service Card.

Airborne Digital System

The Electronics Division of Curtiss-Wright Corp. has developed a versatile, low-cost airborne digital data system, Model ADS-1. The ADS-1 features a highly accurate digital presentation of "yes-no" type of information not degraded by transmission media. The system includes input multiplexing, an analog-to-digital convertor, output switching, channel identification and parity checking. The ADS-1 has twelve channels, a sampling rate of 120 samples a second, conversion accuracy ±0.2% over the operational temperature range, a 10 millivolt resolution and repeatability and total weight of only 9.5 lbs.

Circle No. 229 on Subscriber Service Card.

Resolver Standard

A resolver standard, offering functional accuracy of 2 seconds of arc, eliminating the null detector and a resolver transmitter mounted in an index stand, has been developed by Astrosystems, Inc.

The Astrosystems Resolver Standard is manually switched to discrete positions when used in resolver testing.

When utilized as a control, the Standard is an extremely accurate forward speed control input device for machine tools, computers, radar simulators and flight simulators.

Circle No. 230 on Subscriber Service Card.

Crystal Transmitter

Vector Manufacturing Company, Inc., has developed a transistorized crystal controlled transmitter, hexagonal in form, weighing approximately four ounces, and of low power consumption. It is an all-silicon transistorized, crystal-controlled phase-modulated unit, capable of transmitting the intelligence from any telemetry subcarrier system.

Circle No. 231 on Subscriber Service Card.

Infrared Cryogenic Cooler

The Model FW-22 Cryogenic Cooler is available from ITT Laboratories. Designed for cooling dewar-type infrared detector cells with liquid nitrogen, liquid oxygen, or liquid air, the ITTL Cryogenic Cooler will operate continuously for 22 hours from filling, 16 hours after 24 hours standby, or proportionate times up to 82 hours otal. The unit may be operated at reduced exhaust pressures to obtain colder temperatures (down to 63°K with iquid nitrogen). Various cool-down imes and operating times are possible by regulating the storage tank pressure.

Circle No. 232 on Subscriber Service Card.

iny Hysteresis Motor

A Size 8 hysteresis synchronous notor developed by Kollsman Motor Corp. is only 0.960 in. long.

Designated Model A3361, the 400-ycle unit provides high efficiency and unt-free synchronous rotation. Torque (pull-in) is 0.025 oz. in.; weight, 1.25 oz. Synchronous speed is 8000 rpm. at 55 Volts. Single-phase and two-hase designs are available. Total power s 5.1 watts.

Circle No. 233 on Subscriber Service Card.

Recording Thermobalance

An automatic recording thermobalance which performs thermogravimetric studies in vacuum or controlled atmospheres at temperatures to 1000°C, s available from American Instrument Co., Inc.

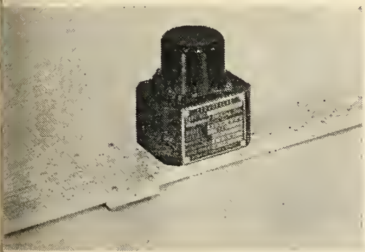
The Thermo-Grav measures and automatically records changes in weight as a function of temperature programed for a selected linear heating rate, or as a function of time at a constant temperature.

Designed to overcome past deficiencies and offer the analyst maximum versatility, the Thermo-Grav removes reaction products as formed, minimizing or eliminating their effect on the reaction of interest.

Circle No. 234 on Subscriber Service Card.

High Purity Servovalve

A new high in reliability of automatic control is available from Raymond Atchley Inc.



The Jet Pipe principle, a design feature incorporated in servovalves, has virtually eliminated contamination as a factor in reliability and performance.

This greater capability assures positive automatic control in all airborne or ground electro-fluid and gas systems without painstaking and expensive contamination control measures.

Circle No. 235 on Subscriber Service Card.

new literature

MAGNETIC MEMORIES—Technical Bulletin 59-J describing series 3100 Magnetic Memories for data processing applications, with capacities ranging from 128 to 4096 words and from 4 to 64 bits per word, has been published by Rese Engineering Inc. It contains a full description of the memories, a block diagram and timing chart, step-by-step operating procedure, and the availability of apertured ferrite plate or core stack plug-ins.

Circle No. 200 on Subscriber Service Card.

BACK-UP RINGS—A 12-page booklet of design, dimensions, and other data on Parbaks, Parker Seal Co.'s continuous and contoured back-up rings, is available from the firm. The booklet describes the characteristics of back-up rings, and discusses the advantages of contoured and continuous rings. Complete dimensions and operating media data are also included.

Circle No. 201 on Subscriber Service Card.

MANIFOLDS AND REGULATORS—Oxweld industrial gas regulators and portable manifolds are described and illustrated in a catalog (Form 55-085) available from Linde Co., Division of Union Carbide Corp. The catalog includes complete specifications and ordering information for regulators that are available for all industrial gases and completely portable manifolds for use with oxygen and acetylene. Inlet and outlet connections are listed according to the American Standards of the Compressed Gas Association. Recommended uses and installations are included in the description of each regulator.

Circle No. 202 on Subscriber Service Card.

ENVIRONMENTAL TESTING—Advanced propulsion and environmental test and research facilities are described by Aerotest Laboratories, Inc., in a 26-page brochure. Complete space orientated laboratory facilities, for functional and environmental testing of components and systems, from sub-miniature electronic to gas turbine engines, are summarized in detail.

Circle No. 203 on Subscriber Service Card.

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1st Mortgage Loan obtained from banks, insurance companies and similar lending institutions.	*50%*
Total financing, secured through local subscriptions and mortgage loans, without cash investment by the manufacturer.	*100%*

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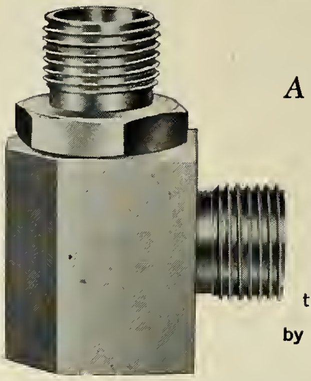
Circle No. 12 on Subscriber Service Card.

Rita Roylyn Says:

The Swing is to *Mini-Tork* Swivel Connectors



A New Product by Roylyn

The free-swinging swivel connectors which have 70% lower torque than the minimum required by MIL specification

ONLY Roylyn's new **MINI-TORK** Swivel Connectors offer *ALL* the exclusive *plus* features that spell reliability of performance in aircraft and missile applications. Roylyn **MINI-TORKS** are available *STERILAB* decontaminated for missile applications. Here are but a few of the multitude of exclusive **MINI-TORK** features:

- Available in tube-to-tube, pipe thread, and bulk head mountings.
- Ball-bearing—for low torque.
- Pressure-balanced—No separation force.
- Designed in accordance with MIL-J-5513A, Amendment 1.
- Zero leakage at 1 psi to proof pressure.
- 3000 psi operating pressure.
- Available with Roylyn rotary lock coupling.
- Universal application for liquids and gases for aircraft, missile, and industrial fields.
- Available for immediate delivery.

For further information, write for Brochure No. AR-005.

DESIGNED • MARKETED BY AIRATERRA "THE BEST CONNECTIONS IN THE WORLD"

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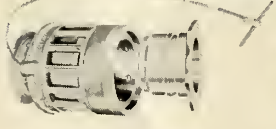
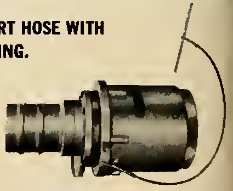
IN JET AIRCRAFT STARTING AND MISSILE AIR CONDITIONING APPLICATIONS, USE ROYLYN AIR START HOSE WITH EITHER THE ROYLYN AIR-START COUPLING OR WITH ROYLYN AIR CONDITIONING COUPLING.



AIR-START COUPLING
Also available with handling ring

AIR-START HOSE or AIR CONDITIONING HOSE



AIR CONDITIONING COUPLING

Information on these products can be obtained by writing for Brochure No. AR-020

names in the news

RAMBUSEK

DOWNS

BAILEY

John B. Montgomery: Vice president d general manager of General Electric's ht Propulsion Division, resigns as of c. 15 to become president of Daystrom, . He is a retired Air Force general and s executive officer to Air Force Secre- y Stuart Symington, director of opera- ns for Strategic Air Command and com- nder of the Eighth Air Force. **Thomas y Jones,** former president of Daystrom, s been named chairman of the firm.

Joseph Rambusek: Former vice presi- nt in charge of sales for Bogue Electric anufacturing Co., joins The Siegler rp.'s Magnetic Amplifiers Division as les manager.

Charles L. Spencer: Named special gineering advisor for Systems Evalua- n for the Development Engineering rp. Since 1954 Spencer has been a con- ltant to the U.S. Navy's Bureau of ips.

Arthur D. Coleman: Joins Interna- nal Resistance Co. as senior quality surance engineer in the firm's high-re- ability resistor project. Was formerly anager of reliability and quality assur- ce with the Systems Division of Clifton ecision Products Co. Inc.

Charles G. Chisholm: Former general les manager, elected vice president-mar- ting of Haynes Stellite Co., a division Union Carbide Corp.

Thomas M. Robertson: Named to the w post of manager of Antisubmarine arfare Planning, at Vitro Laboratories. **illiam L. Freienmuth** replaces Robert- n as acting head of the Systems De- lopment Dept.

George L. Downs: Appointed manager the *Minuteman* program office at the mherst Laboratories of Sylvania Electric oducts Inc. **Robert D. Gray** was named chnical program manager responsible for ordinating the system design.

William H. Bailey: Appointed execu- ve vice president of Nuclear Corpora- n of America. For the past three and e-half years he has acted as business manager of several weapons systems projects at Martin-Orlando.

Jerry Gabriel: Former vice president in charge of research and product marketing for Dyna-Therm Chemical Corp., joins Jack & Heintz, Inc., as director of long-range market and product planning, a newly-created post.

Charles K. Hersh: Former research engineer, promoted to senior engineer at Armour Research Foundation.

William J. McClenahan: Former sales manager, promoted to marketing manager for Sperry Rand Corp.'s Sperry Electronic Tube Division.

Henry Burlage, Jr.: Former director of the Propulsion and Aerodynamics Laboratory of Case Institute of Technology, and associate professor of aerodynamics engineering, joins the National Aeronautics and Space Administration as manager of advanced technology programs for liquid-propellant rocket engines.

Dr. Sidney A. Bowhill: Associate professor of electrical engineering at Pennsylvania State University, elected to the board of directors of Dorne and Margolin, Inc.

Arthur E. Rowland: Joins Autonetics, a division of North American Aviation, Inc., as chief, Sales Engineering for Armament and Flight Control Products. Was formerly Western region manager of General Precision Equipment Corp.'s Kearfott Division.

Paul N. Bertness: Former advertising manager of Consolidated Electrodynamics, joins Microdot Inc. as advertising and public relations manager of the firm's four divisions: Connector, Cable, Electronic Transformer and Instrumentation.

Dr. Louis R. Lavine: Assistant manager of programing research and development, succeeds **Dr. Saul Rosen** as manager, programing research and development, for the Computer Division, Government and Industrial Group, Philco Corp.

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and Magnetic Materials, ONR, IF
AIME, AIEE, AIP, Hotel New York
New York City, Nov. 14-17.

IRE Professional Group on Product
Techniques, Fourth Annual Conf
ence, Boston, Nov. 15.

Engineering Applications of Probabi
and Random Function theory, Pur
University, Lafayette, Ind., Nov. 15-

Air Force, Navy, Industry Propulsion S
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fied) co-sponsored by ARDC's WAI
and Southwest Research Institute, I
ton Hotel, San Antonio, Nov. 15-1

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Joint Symposium on Space Navigati
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Reorganizing the Pentagon

PRESIDENT-ELECT KENNEDY'S Reorganization plan for the Department of Defense and the military services will shake the Pentagon to its five-sided foundations.

There have been seven Secretaries of Defense. James Forrestal was sworn in as the first on Sept. 17, 1947. His successors were Louis Johnson, Gen. George C. Marshall, Robert A. Lovett, Charles E. Wilson, Neil H. McElroy and Thomas S. Gates, the incumbent.

They have been good, indifferent or bad according to the viewpoint, and each has left the mark of his methods or convictions on the military establishment.

But none of them—not even Forrestal, who put the organization together—faced the job which lies ahead of the new Democratic Defense chief under the reorganization plan which will be proposed by Kennedy (see page 8).

In this drastic overhaul, which the president-elect has forecast in his campaign speeches, three major points stand out. They are 1) abolishing the three service secretaries and their assistant secretaries, 2) disbanding the Joint Chiefs of Staff as a unit and 3) substituting one Chief of Staff for the Department of Defense—to be the nation's highest uniformed official.

Kennedy feels, we understand, that the service secretaries are both a symbol of disunity and a waste of manpower. Their authority has been greatly down-graded since DOD was organized until now they are simply petitioners, a channel through which papers move on the way to DOD. Kennedy feels the services will be better represented by either assistant or under-secretaries working directly with the Secretary of Defense.

With the service secretaries will go what Kennedy has called the "proliferation" of assistant and under-secretaries. Their jobs would also be combined under DOD.

Disbanding the Joint Chiefs of Staff and replacing them with one Chief of Staff for Defense is a move which the new President hopes will help restore the decision-making processes in the military.

Many, if not most, of the really important problems which have come before the JCS in the past few years have reached a two-to-two vote stalemate. Important decisions, ranging from the choice of new weapon systems to strategic planning, have been referred to study groups. In some instances the decision of the study group has then been referred to another study group, with the actual decision going to the Secretary of Defense or the President after long delay.

Under the planned reorganization the National Military Council, which would probably include the Service Chiefs of Staff, would make recommendations but the decision would be up to one military man—the Chief of Staff for Defense.

Much of the Kennedy plan is being recommended by a committee of public officials and private citizens with considerable experience in the Pentagon's intricacies. It will be presented to Congress, we are told, as one of the first orders of business in January.

WHETHER THE PLAN, or what goes through after the inevitable compromises, will cure the major ills of our military system is difficult to foresee.

But one thing is certain. Something must be done to restore the decision-making processes in the Pentagon. Something must be done to prevent the delays of referrals to study groups, the compromise of passing to committee. Something must be done to eliminate the layer upon layer of little officials who can always stop action but seldom approve it, who have the power of the lower-drawer veto.

If the new plan will just give the man on the job the authority and the confidence to say "do it"—then the plan will be good.

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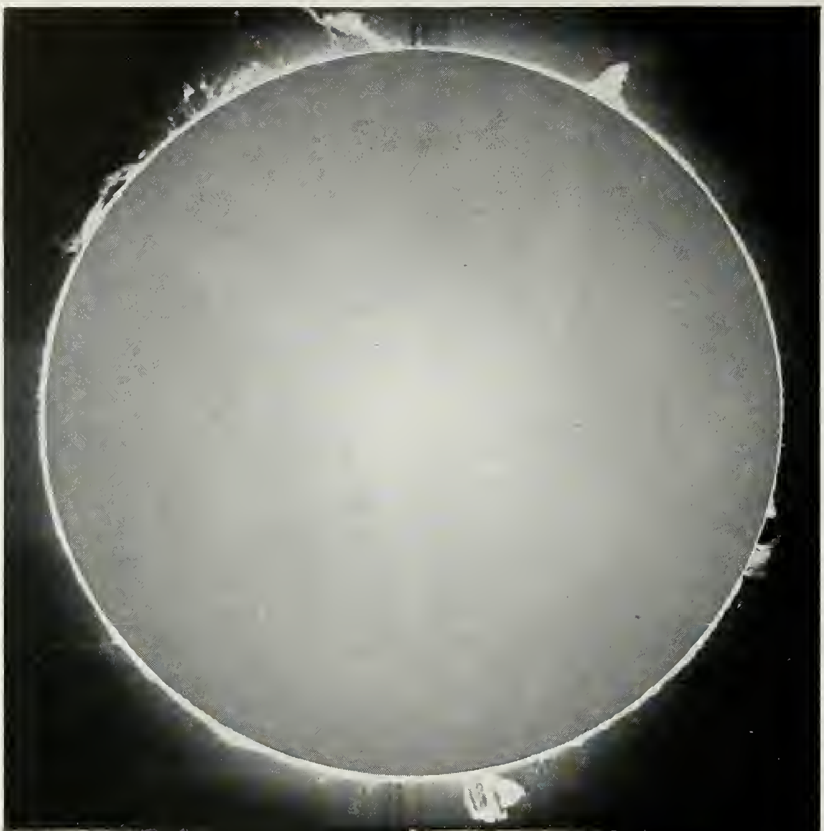

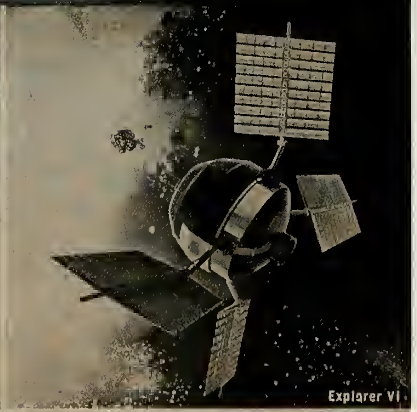

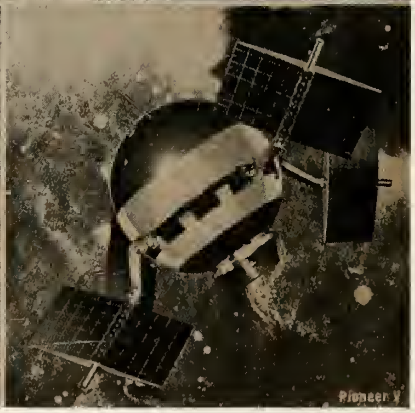

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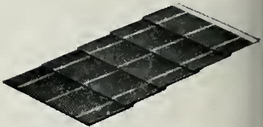

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missiles and rockets

Volume 7, No. 21 November 21, 1960

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THE COVER

USS George Washington receives one of its combat-ready Polaris missiles at night during round-the-clock loading before sailing out to go on station. See story on p. 10.

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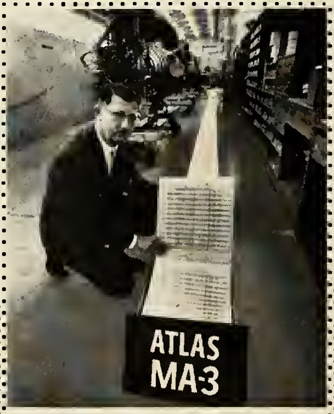

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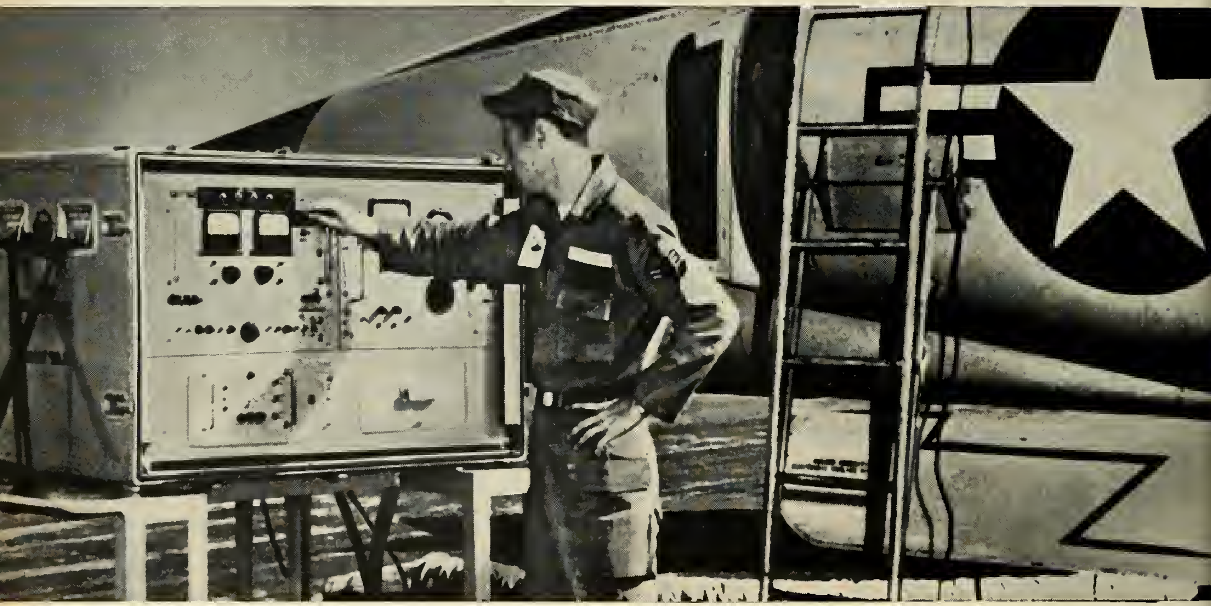

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The Countdown

WASHINGTON

Dissidents Return?

President-elect Kennedy is expected to call on some Eisenhower Administration dissidents to help throw the defense/space effort into higher gear. Among those who may return, perhaps on a presidential advisory basis, are former Army Generals Taylor, Gavin and Medaris. Trevor Gardner, the former Air Force Missileman, also could get an invitation to a DOD post.

One-upping the Russians

Big problem facing Kennedy after Jan. 20 is making good his campaign promise to put the United States ahead of Russia in space. His desire to seize the initiative can only be translated into a greatly-expanded man-in-space effort, more money to accelerate large rocket booster programs. With manned spacecraft more than four years away, the new administration can be expected to draw a bead on the moon and try to beat the Russians to a lunar soft-landing.

Supplementary Defense

Breakdown of the $2 billion to $3 billion supplementary defense budget Kennedy is expected to hand Congress in January could look something like this:

–$600 million to put *Polaris* submarine program on a "keel-a-month" plan.

–$500 million for the Strategic Air Command's air alert.

–$500 million to speed up *Minuteman* and *Titan* base building.

–$400 million to let the Army modernize and buy some of the new missiles it has been developing.

–Possibly a "substantial" downpayment for putting *Nike-Zeus* into production.

NASA Repeater Satellite

Look for an active repeater communications satellite contract to be let soon by NASA. Action on a privately-owned satellite, however, must wait until the FCC decides on an AT&T application for a microwave channel.

On Capitol Hill

All congressional investigations into the nation's space program—including the *Mercury* project—will be kept on the back-burner until after Kennedy takes office. Some of the items currently under scrutiny include possible duplication of moon-mapping (Army, AF, NASA, and the Interior Dept. are all in the act) and some Navy complaints that the AF is giving it short shrift on launch schedules for next spring.

INDUSTRY

AINT Contract Due

Award of a contract for a prototype *SAINT* test vehicle probably will be made by the AF Ballistic Missile Division before the end of the year. About three dozen bidders are in the competition for the satellite to inspect and destroy hostile spaceware.

Minuteman Production

Growing size of the *Minuteman* ICBM program is indicated in the huge $30-million AF Plant 78 being built at Tremonton, Utah, to produce first-stage motors. Thiokol will operate the plant.

Test Stands for the F-1

Two test stands for static-firing Rocketdyne's 1.5-million-lb.-thrust engine are almost ready at Edwards AFB. Test stand 1a is designed to hold the engine under full power. . . . At Sunnyvale, Calif., Lockheed is getting ready to add a $4-million engineering laboratory for its Missile and Space Division. Lockheed says the move will be accompanied by a "significant rise" in employment.

High Cost Payloads

Scanning the horizon to 1970, JPL scientists figure that the scientific instruments needed for exploratory work on other planets will cost more than the launch vehicles to get them there. The expensive items: remote control devices.

In From Space

MIT is joining the growing list of contractors in the AF-ARPA *Defender* program. The Institute's Lincoln Laboratory will research problems relating to both ballistic missile defense and location of and communication with, re-entering space vehicles. Field experiments are being conducted with NASA's Wallops Island, Va., station.

INTERNATIONAL

Skybolts for Victors?

Handley Page denies that its Victor bomber can't carry the *Skybolt*, contending that the Victor I already has flown with the equivalent weight and drag of two *Skybolts* under its wings. The company says the bomber could be fitted with an ALBM made in Britain, if the *Skybolt* goes only on Vulcan Bombers.

Blue Water: Secret Sell?

Rumors are circulating in London that the British War Office is secretly sending a *Blue Water* tactical missile to the U.S. in hopes of getting a $140-million order from the U.S. Army. The missile is being offered as a substitute for *Sergeant*. Unless America buys the *Blue Water*, observers feel it unlikely that the rocket will be bought by the British because of the high cost of producing it in limited numbers.

Red Astronaut

The vice president of the Soviet Academy of Medicine, V. Timakov, reports that the first Russian astronaut has been selected. He is a jet pilot, smaller than average in size, who has been dividing his time between learning new sciences, handling complex instrumentation and physical training.

Overseas Pipeline

The RAF is said to be trying to wrest operational control of the *Thunderbird* air defense missile from the Army. That contract for an advanced Mark I *Thunderbird*, incidentally, is reported to be worth $56 million to English Electric . . . Nord's CT 41 target drone is under consideration for NATO use . . . Eight European nations are meeting in Geneva Nov. 28 to discuss creation of a common space research center . . . The Indian government is thinking about buying *British Bloodhounds* and U.S. *Sidewinders*.

PATRICK HENRY *later this year will become second FBM sub to go on station.*

'Most Significant . . .'

Polaris Sub Sails to Gu

Triumphant departure of George Washington changes power picture; Navy to press for bigger fleet

by James Baar and William E. Howard

CHARLESTON, S.C.—Arrival of the *Polaris*-launching submarine George Washington sometime this week beneath the ocean's surface somewhere within range of the Soviet Empire is a major event of twofold significance:

–It introduces a mighty, new element—the hidden, mobile missile base—into the complex equation of the world balance of power.

–It opens a renewed drive by the Navy for authority to construct a two-ocean, five-squadron fleet of *Polaris* submarines.

The George Washington with her 16 H-bomb-tipped missiles sailed from the Charleston *Polaris* Depot at a few minutes after noon on Nov. 15. She was expected to reach her station in about 10 days.

The Patrick Henry—second of the *Polaris* fleet—is scheduled to join the nation's strategic forces in less than six weeks. She is expected to begin taking on *Polarises* at Charleston about the end of the month or early December.

Three more *Polaris* submarines—the Theodore Roosevelt, Robert E. Lee and Abraham Lincoln—will follow during 1961, putting a possible total of 80 1400-mile-range missiles around the periphery of the Soviet land mass.

An operational command post for the *Polaris* fleet has been in operation at Norfolk Naval Base since October under the command of Adm. Robert L. Dennison, commander-in-chief of the Atlantic. The post was established by Vice Adm. Elton W. Grenfell, commander of the Atlantic Submarine Fleet.

Here would come the order from the Joint Chiefs of Staff to launch *Polaris* missiles.

• **Only beginning**—At present, the Navy has authorization and funds for the construction of 14 *Polaris* nuclear-powered submarines and purchase of long-lead time items for five more. This is less than half the 45 submarines that the Navy feels the nation should build, at a total cost including R&D of about $9 billion.

The Navy is expected to push for 12 *Polaris* submarines in the FY ' budget of the Kennedy Administratic and possibly four more in the expecte FY '61 supplemental. Moreover, tl Navy probably will ask for more R& money to press work on the A3—tl 2500-mile range *Super Polaris.*

The authorization of a doze subs—one keel would be laid a mon —would cost an estimated $1.3 billio The authorization of four more wou cost about $600 million.

A 45-ship *Polaris* fleet would enab the Navy to deploy five nine-sh squadrons. A high-ranking Nav source says three probably would o erate in the Atlantic and two in tl Pacific.

• **Two-month submersion**—Oper tional plans of the George Washingtc were closely guarded. However, a fe facts about her orders were indicat before the great undersea ship-of-th line sailed.

More than 60 miles off the Ea Coast of North America she close her hatches and submerged with plan to surface for two months. The following a secret course, she head for the European littoral. For tw months she will lurk somewhere in tl cold wastes of the North Atlantic, tl Arctic and possibly other ocean are from which her missiles with the range of 1400 statute miles could stril deep into European Russia.

Sometime before mid-January aft the Patrick Henry has been deploy the George Washington will turn ar head for home. She will be resupplied New London, the ship will be turn over by her Blue Crew to her Go Crew and once again she will head f an unknown station.

The *Polaris* Sub Tender Proteus w service the George Washington at Ne London before sailing for Holy Loch Scotland. Patrick Henry will be the fir *Polaris* sub to be serviced at Ho Loch.

• **12-hour shifts**—The Georg Washington arrived at the isolat Charleston *Polaris* Depot 16 miles the Cooper River from the Atlant shortly after Nov. 1. The nuclea tipped missiles were loaded onboard about a week—half the time expecte

eace

However, up to the last day, the sub's rew of more than 100 officers and nen continued to load supplies ranging rom delicate guidance components to ettuce.

The day before she sailed, with upplies still piled on the pier, the Navy lemonstrated how the missiles were oaded from their special double conainers into the sub's great launching ubes. But the missiles had long since een slowly slid into the tubes, checked ut and accepted by the George Washngton's skipper, Cmdr. James Osborn.

Osborn and his crew had been vorking 12-hour shifts for two weeks o prepare for sailing. The pace the veeks before at New London and Cape anaveral had been much the same.

At 11 o'clock of the day they sailed he pier was clear of cartons and was ned with the officers and men of the Navy Weapons Depot. A band played riskly in the warm sunshine. Osborn nd his officers and two thirds of his rew stood at attention on the George Vashington's deck.

• **Most significant journey**—Adiral Grenfell presented the crew with ne Navy Unit Commendation Ribbon. Ie presented Osborn with the Legion f Merit. Then there were speeches.

"This is the ship and the crew who nay indeed be the one military system apable of guaranteeing peace in the vorld—for it is this ship and her crew nd those following who can really proide a retaliatory capability as well as a eterrent," Grenfell said.

Adm. Arleigh Burke, Chief of Naval perations, talked to the crew by radio rom the Robert E. Lee, which was ruising in the Atlantic with the Joint hiefs of Staff.

"I wish you the best of luck in the nost significant journey that any man-f-war has ever taken," he said.

Then the great 6000-ton submarine as edged from the pier by two tugs. nce in the middle of the Cooper River er nuclear-powered screw began to hurn the placid water.

As the band played "Anchors weigh," the George Washington noved slowly away from the shore ith Osborn in the sail jauntily smokg a cigar. In a few minutes she eaded down the river until she was nly a dark silhouette.

Out in the Atlantic Destroyers swept ne sea for Soviet subs. The fleet's new ueen of war, the most powerful ship ver built, was about to take command.

Navy Defends Holy Loch

The Navy this week hit back at critics of its decision to establish an advance *Polaris* base a Holy Loch in Scotland.

The essence of the Navy's argument given both publicly and privately is that the Holy Loch base can hardly be called a base at all in the usual sense of the word because it will be mobile.

The calm water of the Scottish loch will be used only as an anchorage for the Submarine Tender Proteus and a floating drydock which could be located anywhere. The real *Polaris* bases—the nuclear-powered submarines and their H-bomb warheads—will be at sea.

Rear Adm. Kenmore McManes, commandant of the 6th Naval District and Charleston Naval Base, said at a luncheon before the George Washington sailed:

"We are not—repeat not—establishing a base in Scotland. What we are doing is sending over a tender. When you think of a base the public generally thinks of something like New London or Charleston."

• **"We're not vital"**—Capt. Richard B. Lanning, commander of the Proteus, elaborated on the role of his ship while sitting aboard her in Charleston harbor.

"We would like to think we are absolutely vital to the *Polaris* system, but we're not," he said. "They don't need us. They could come home. We're saving transit time."

As to the choice of Holy Loch, Lanning said:

"We don't have any umbilical cord at all. We have a few piers that we can use if we want. A number of our men will live ashore with their families. But we can go anywhere. It's a matter of convenience, not necessity. We're not a fixed base."

Overseas, the uproar over the proposed *Polaris* base appeared more and more to be a political football that the left-wing Laborite groups and supporters of the Campaign for Nuclear Disarmament sought to keep in motion to press their drive for unilateral disarming of Britain.

As the highly-respected *Economist* put it: "The Campaign for Nuclear Disarmament, as it happened, was in need of a juicy bone of this kind to gnaw at the present time."

• **Factors in favor**—However, supporters of the Government's position in favor of the base appeared to be carrying the day.

One reason was the shooting down of the contention that the presence of the Proteus and a *Polaris* submarine on occasion would make Holy Loch a target for Soviet missiles.

Supporters of the base pointed out that Holy Loch already was a target since the Royal Navy's Third Submarine Flotilla and the British Tender Adamant are stationed only 25 miles away in Gareloch. The Clyde Valley is a heavy industrial center, and other military targets are located in the area.

Economics is also a factor favoring acceptance of the base. The area has one of the highest unemployment rates in Great Britain.

• **Useful Proteus**—Present Navy plans call for the arrival of the Proteus in Holy Loch sometime in February. The *Polaris*-launching submarine Patrick Henry—second of the *Polaris* fleet—will be her first customer.

The 18,500-ton Proteus and her crew of 895 officers and men is capable of providing a *Polaris* submarine with extensive servicing.

The submarines can be completely resupplied with food, spare parts and other supplies including the replacement of any *Polaris* missiles that may have developed breakdowns beyond the ability of the sub crews to correct. Twenty spares can be carried aboard the tender.

The Proteus shops are capable of performing extensive work on missiles and on the submarines themselves including the replacement of modules inside the sub's nuclear cores. They can also work on nuclear warheads.

The Proteus is specifically assigned to servicing the nine ships of the first *Polaris* squadron—Subron 14. However, as Lanning put it:

"If another nuclear sub came by, of course we'd help out if we could. If a seaplane came by and asked if we had any extra ice cream, we'd provide that, too."

PMR May Stretch to Indian Ocean

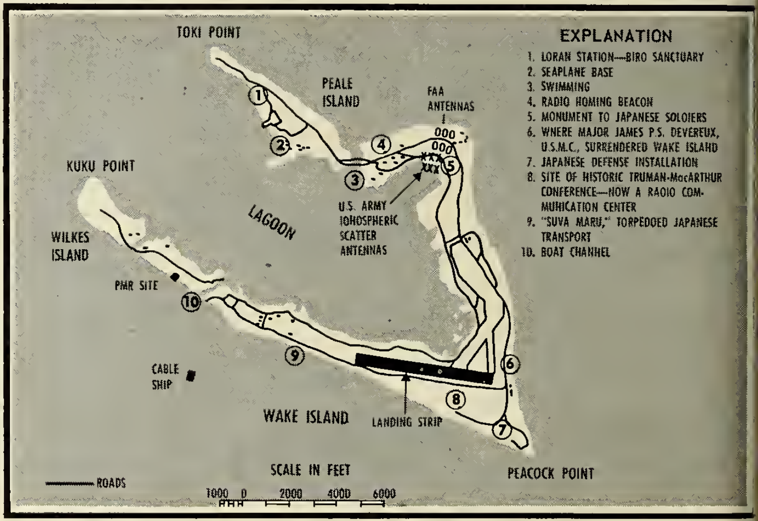
Range ships by next spring will be ready to extend tracking capability to Indian Ocean, if necessary; facilities added in Philippines

by Frank G. McGuire

WAKE ISLAND—The Navy may extend the Pacific Missile Range to the Indian Ocean from its present terminals here and at Eniwetok sometime next year.

A splash net in the Indian Ocean would give the range the capability of handling training shots of the *Titan* ICBM, in addition to its tracking role in the *Dyna-Soar* program. By spring, three PMR range ships will be equipped with SILS (Shipboard Impact Locator System) to extend the net, if required, to meet with the tracking and communications network of the Atlantic Missile Range at parallel 90° West.

Range capabilities are being expanded with the recent addition of MILS (Missile Impact Locator Systems) stations, instrumented aircraft, and *Transit* tracking stations in the Philippines and elsewhere.


TOKI POINT
PEALE ISLAND
FAA ANTENNAS
KUKU POINT
LAGOON
U.S. ARMY IONOSPHERIC SCATTER ANTENNAS
WILKES ISLAND
PMR SITE
CABLE SHIP
WAKE ISLAND
LANDING STRIP
PEACOCK POINT
ROADS
SCALE IN FEET
1000 0 2000 4000 6000
1
2
3
4
5
6
7
8
9
10
EXPLANATION
1. LORAN STATION—BIRD SANCTUARY
2. SEAPLANE BASE
3. SWIMMING
4. RADIO HOMING BEACON
5. MONUMENT TO JAPANESE SOLDIERS
6. WHERE MAJOR JAMES P.S. DEVEREUX, U.S.M.C., SURRENDERED WAKE ISLAND
7. JAPANESE DEFENSE INSTALLATION
8. SITE OF HISTORIC TRUMAN-MacARTHUR CONFERENCE—NOW A RADIO COMMUNICATION CENTER
9. "SUVA MARU," TORPEDOED JAPANESE TRANSPORT
10. BOAT CHANNEL

MAP SHOWS PRESENT terminus of Navy's Pacific Missile Range at Wake Island, typical downrange installation. Station at Kaneohe Bay is larger, more complex.

• Grandstand seats for re-entry—At present, PMR terminates at this wishbone-shaped trio of coral islets barely clearing the surface of the Pacific at 19°15′ N. latitude and 166°37′ E. longitude. The island's three square miles of land surface have 20 miles of shoreline.

The PMR installation itself is on the south shore of Wilkes Island, the least used portion of the atoll.

Tower operators in the airport control center have reported seeing re-entering *Atlas* vehicles plunge into the sea. They describe the colors of re-entry as "brilliant." The vehicle separates into two packages just before water impact, they say, and one package explodes while the other enters the water intact.

The explosion undoubtedly signifies a successful arming and fuzing operation, while the second package carries SOFAR bombs.

• Building investment—During the fiscal year ending June 30, PMR completed military construction totalling $15 million. This includes missile impact locator system buildings at Kaneohe, Eniwetok, Midway and Wake Island. In addition, runways for support aircraft at Point Mugu PMR headquarters and other facilities were constructed. Sea-level climatic labs, altitude and shock facility, range operations building, receiver facilities and other installations have been completed at Point Mugu, Point Arguello, and San Nicolas islands.

Current construction at Point Mugu for PMR consists of 15 major projects with a combined cost of over $7.5 million. Heading the list is a missile projects building for work on the *Eagle* missile system and an airborne tactical data system. The meteorological building is being expanded to boost current range capability in support of *Tiros* and other satellites. Frequency control buildings, instrumentation, photo installations, calibration and hangars are also being expanded. Construction no underway represents about a third c current construction funding for th overall PMR setup at Point Mugu.

Total investment in PMR to date . $130,358,000, not including the Nav Missile and Astronautic Center at Poi Mugu or the Naval Air Station ther Estimated expenditure for Fiscal 196 is about $50 million, according to Nav figures.

Future plans call for building i strumentation sites at a number islands. These would very likely inclu Manus and Christmas Island. Manus east of New Guinea and Christm is northwest of Australia.

Installation of the missile impa locator system (MILS) at Eniwet was completed recently, and the MIL unit at Midway is expected to be fi ished shortly. Neither is expected to completely operational before the e of the year, however. The MILS syste used at the downrange stations w developed by Bell Laboratories, man factured and installed by Western Ele tric, and is operated and maintained Bendix Corporation.

First on the Scene

MISSILES AND ROCKETS *Correspondent Frank G. McGuire is the first reporter sent by any publication to visit PMR's downrange facilities and send back a first-hand story.*

PMR Capital: (Cumulative in millions of dollars)

Fiscal Year—	1957	58	59	60	61
Land	$ 3.8	2.7	3.2	3.2	3.2
Facilities	34.9	35.0	35.0	65.0	110.0
Equipment	30.2	31.7	46.4	53.0	109.0
Total	68.9	69.4	84.6	121.2	222.2

• **Air support**—Projects for rapid ata acquisition and reduction are also nder way at Point Mugu. Three WV-2 ircraft have just been modified to act s airborne multi-purpose range instruientation carriers anywhere along the ystem. These Lockheed Constellations rovide PMR with frequency monitorig and interference control, airborne IC, telemetry data recording with mited real-time readout, and terminal npact data on ballistic missiles and atellite instrument capsules.

In addition to the three Constellaons, a Lockheed Electra has been iodified for telemetry duty, carrying quipment in what was formerly the enter seat section on the former apital Airline plane. In addition to ie internal gear, a special radome was istalled for antennas on the upper iselage.

• **Wake's set-up**—Typical of PMR ownrange installations is the complex ere at Wake Island. The visible "comlex" consists of one small concretelock building about 30 x 8 ft. in size, ontaining an instrumentation room, a ommunications room, and various adiinistrative and support offices. There a small power house near the aironditioned main building. Three to ve permanent civilian personnel man ie station.

The MILS setup includes two major ibsystems: the SOFAR (sound fixing id ranging) and Splash Detection Sysms. SOFAR itself consists of two ets, the broad ocean area net and the iiniature SOFAR net for great accuicy in a smaller area.

SOFAR depends on subsurface exlosions to make a fix on a missile imact. Small bombs are set off 2500 feet nderwater by the re-entry vehicle's ecovery package when it strikes the cean surface, providing SOFAR with ie necessary explosion. The broad cean area system has great range, but cks the extreme accuracy of the miniure SOFAR net.

SOFAR operates on the triangulaon principle, with stations at Wake, Iidway and Eniwetok islands comparg data for a precise fix. As of now, iere are four pairs of hydrophones in e SOFAR net at Wake.

• **Helped spot Red rockets**—The lash detection system records the cation of an object striking the ocean irface. PMR did not give the range of e system, but it is known that such MR equipment aided in pinpointing e impact location of Soviet rocket ots into the Pacific.

Hydrophones are located off Wake two patterns, the four pairs mennned for the SOFAR setup, and anher set of six in the splash net. These e patterned in a pentagon, with the xth sensor in the center. Distances involved were not disclosed. The signals from both nets in the MILS system are transmitted by cable to the shore station, where they are recorded, timed and correlated.

No airborne telemetry is included at present in the Wake/Midway/Eniwetok complex, all instrumentation being underwater. Seven channels of hydrophone telemetry are handled by the three tape recording racks at the shore installation. About 10 racks of equipment, including the three tape recording units, are at the site, consisting of WWV receiver, a secondary time standard, oscillographs, oscilloscopes, and other equipment. There is also a separate communications room in the small building. One voice and one teletype circuit, both furnished by the Federal Aviation Agency and designed by Collins Radio, handle communications between Wake and the PMR main downrange station at Kaneohe Bay on Oahu in the Hawaiian Islands.

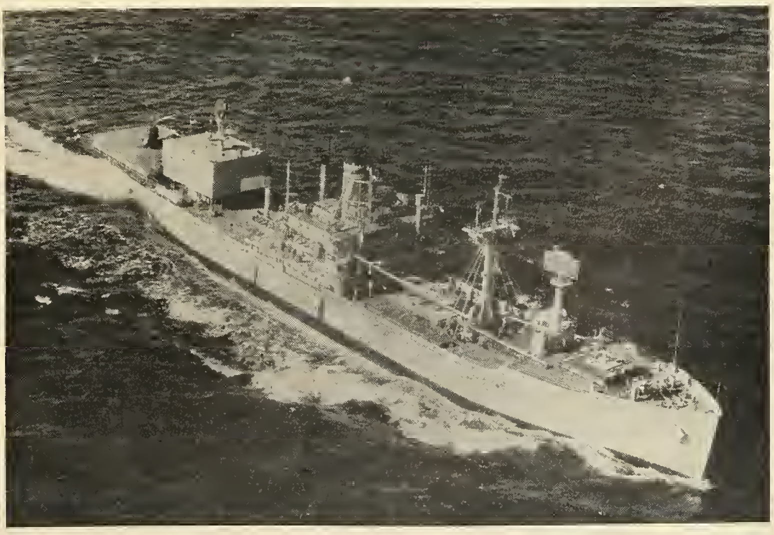
• **Small staff**—The administering government agency on Wake Island is the Federal Aviation Agency, which took over control of the island from the Navy in 1947. Island population is now about 1180 people, mostly employed by Pan American, Overseas National Airlines, and other firms engaged in various phases of trans-Pacific aviation.

Although Wake is essentially the present terminus of the Pacific Missile Range, with support from stations at Midway and Eniwetok, the downrange station at Kaneohe Bay is larger and more elaborate. Located at the Marine Corps Air Station at Kaneohe, the PMR site was activated in September, 1958, and recorded the first IRBM impact in December of that year.

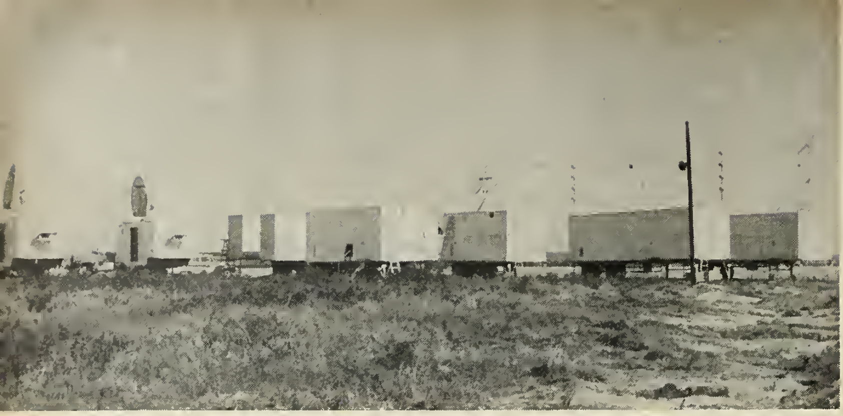
Personnel at Kaneohe number about 120 military, civil service and civilian contractor employees. From the original MILS system at the Oahu station, this Hawaiian complex has grown to include telemetry and tracking units on the islands of Kauai and Hawaii, as well as two telemetry/tracking ships and numerous aircraft.

Kaneohe handles communications to Barking Sands, Kauai, and South Point, Hawaii, as well as to Wake, Midway, Eniwetok and Kwajalein. Bendix Corporation is contractor for the communications net, which is in 24-hour operation.

A teletype circuit carries traffic from Kaneohe to Point Mugu, backed up by a hot telephone line for MILS readiness and range safety traffic. There is also the voice/teletype circuit previously mentioned between Kaneohe



USNS HAITI VICTORY is one of two satellite recovery ships under operational control of PMR. Other is USNS Dalton Victory. Equipment includes two helicopters.



THESE VANS at Barking Sands, Kauai, Hawaii, are operated in support of Pacific Fleet Missile Training. Missiles are recovered on adjoining landing strip.

and Wake. Other teletype circuits connect Kaneohe with Barking Sands and South Point.

• **Recovery headquarters**—The Hawaiian complex is the center of activity during satellite recovery operations, and the three stations provide the same type of triangulation afforded further downrange by Wake, Midway and Eniwetok. Kaneohe is the nerve center of the *Discoverer* recovery operation, acting as coordinator of communications between surface recovery ships, PMR aircraft, and Point Mugu.

The Barking Sands station consists of a mobile van located at the western tip of Kauai, providing telemetry and communications services. Equipment used here was formerly used as mobile units on the mainland. The vans are completely self-contained and independent of outside technical support.

Backup systems insure reliability of all electronic circuitry. If the primary transmitter fails, a secondary transmitter in the command control van automatically takes over. The vans are operated and maintained under contract by Chance Vought.

The South Point Station is more fully equipped than Barking Sands, being furnished with a 60-ft.-high-gain antenna dish with command control, timing, telemetry recording equipment, and associated units. The command control unit can operate satellite transmitters designed for switching on and off during orbital passes over ground stations. In addition, it can send signals to change a vehicle's mission.

• **Plans for Transit**—Now under construction at South Point is a microlock station to be used in conjunction with the *Transit* satellite program. The equipment, designed and fabricated by the Naval Ordnance Test Station at China Lake, Calif., will be operated under contract by the University of New Mexico.

A station for the *Transit* program will also be built at San Miguel, in the Philippines, with operational control being vested in PMR.

The Philippine station, as well as others in this particular project, will have two five-ft. antennas, two Doppler receivers, a WWV receiver for time signals, and data reduction equipment. A teletype link will handle communications.

In addition to the island stations, the PMR instrumentation system includes a number of ships, one of which made the first successful recovery of a satellite capsule re-entering the earth's atmosphere from orbit, *Discoverer XIII*.

Besides their recovery role, the ships are on a "not-to-interfere" basis to support other PMR operations and normal fleet operations.

Various smaller ranges or recovery areas are contemplated as part of the eventual overall PMR setup, with cooperation from various governments in the Pacific area.

These include a tracking range for ballistic missiles and *Dyna-Soar* extending from Point Arguello westward down the range and also passing over Biki atoll, Manus Island, New Guinea, ai the northwest coast of Australia, wi tracking facilities also on Christm Island in the Indian Ocean, coveri the area between Christmas and t Australian coast.

On Manus Island, an equatori launch site may be built, taking a vantage of the vast empty expanses the east, so that the earth's rotation c be exploited to help the vehicle atta required velocity.

In addition to the equatorial laun site, an equatorial recovery area is bei considered; it would extend 1000 na tical miles along the equator, eastwa from the 180° meridian, and just abo reaching Christmas/Pacific.

Until the operation of prograr such as *Dyna-Soar*, requiring a 15,00 mile range, the most important proje on the range in the near future a *Titan* and the *Nike-Zeus* test prograr *Titan I* tests will be well under way the time the extension plans are i plemented, but if the present timetab are maintained, *Titan II*, with its r ported half-the-world range, will its first just at the time when PMR equipped to handle such a vehicle.

Nike-Zeus testing, with no speci firing date yet released, apparently w not utilize the extended portion PMR, but will involve Kwajalein Islar *Atlases* fired from the West Coast w be used as targets for *Nike-Zeus* fir from Kwajalein.

The Army is building installatic "in and around" Kwajalein for the tes PMR will provide range support.

PMR has also assigned helicop and aircraft units to Kwajalein to su port the programs. These will oper between Kwajalein and Roi-Nam islands which will work jointly on *Ni Zeus* and the *PRESS* (Pacific Rar Electro-Magnetic Signature Study) pr ect to detect and identify ballistic m sile warheads. It will also try to d criminate warheads from decoys.

For Project *PRESS*, an Advanc Research Projects Agency progra the Army will experiment with ra systems of advanced design and "otl sensing devices" on Roi-Namur. *PRE* is a part of the overall Defender p gram aimed at developing ballistic m sile defense measures. *PRESS* is defir as "a study of the exoatmospheric a terminal physics of ballistic mis flight."

Army Ordnance Missile Comma is acting as ARPA's executive agent *PRESS*, and has awarded Western El tric a contract for $1 million to ins a submarine cable between Kwajal and Roi-Namur for communicati and data transfer. Western Electric buy the cable from Simplex Wire of Newington, N.H.

Range Programs:

Able III & IV
ADTS
Atlas ICBM
Bullpup (A) & (B)
Caleb Satellite
Centaur
Composite Radiation Satellite
Corvus (I)
Courier
Discoverer
Dyna-Soar
Eagle
Hawk
Hummingbird
Hydra
Hyperjet
Jaguar (Probe)
Mach 2 Expendable Target
Mach 2 Recoverable Target
Mercury
Midas
Minuteman ICBM
MORT (Fleet Training)
NERV
Nike-Zeus (Jet-Head, Weapon System, Target)
NORT (Fleet Training)
Ozarc
Pershing
Phoenix
PRESS
Regulus I
Rella (Probe)
Samos-Atlas
Scout
Sergeant
Sidewinder
Sparrow III
Sunflare
Talos
Tartar
Tepee
Terrier I
Thor IRBM
Tiros
Titan Training Program
Tophat
Transit
Tumbleweed
Typhon
WS/GAR-9

PMR Downrange

Special Report

A Very 'Can-Do' Outfit Always in 'State of Flux'

Adm. Monroe

(The following is an exclusive Missiles and Rockets interview with Rear Admiral Jack P. Monroe, commander of the Pacific Missile Range, on the future of PMR.)

Q. *Admiral Monroe, there has been some friction in he past between the Vandenberg Air Force base and Point Arguello launch facilities. How does this situation stand now?*

A. The Air Force and Navy are working together exremely well in a very cooperative attitude. The friction you refer to was, I think, the type of friction you could expect to get when any major agencies are required to work together in a new field such as this. The entire safety facilities of PMR, which initially were divided between he Air Force and the Navy, have now been turned over entirely to the Navy. We have Air Force and Navy officers working together at the safety headquarters and working together very amicably, too. All of our areas of disagreement have been ironed out and we are getting along exremely well now.

Flexibility makes it possible to take care of major jobs like Nike-Zeus . . . "this is our life"

Q. *What determines which vehicle will be launched from which base? The Discoverer series is launched from Vandenberg, but the Samos and Midas will be fired from Arguello. Why is this when there are already Atlas pads at Vandenberg, and the Samos and Midas use the Atlas booster?*

A. The *Atlas* Pads at Vandenberg were put there for training shots. They are built to shoot to the west, and they re built to train Air Force crews. This is not compatible with research and development programs such as *Samos.* They are mutually interfering. So the R&D programs, which may someday become operational programs, would therefore interfere with training. The pads built for the *Samos* program can be used for other *Atlas*-boosted programs that go into polar orbits.

Q. *Can you give us some indication what the future of he range is? We have noticed that the original funding figures mentioned in connection with PMR are not consistent with what is currently being spent. Has DOD reduced emphasis on development of PMR or is it going ahead as originally planned? We heard a figure of $4 billion to be spent over a 10-year period, and to date we understand the investment is only $130 million.*

A. When PMR was established in 1958, we were given the job of designing, planning, developing and building it. We then conducted a six-month study to find out what would be needed in the next 10 to 20 years. We talked to all the military services, government agencies and industry segments that would be likely to put a project on the range. This was done so that we could build a facility to provide the basic services needed. If the money was not available to put in all the necessary capabilities, then at least we wanted to build in a capability of future expansion. We didn't build ourselves into pockets, in other words.

We presented this plan to DOD, well knowing that the only money you can get these days is for programs which you can demonstrate are likely to come to the range. So that's the kind of money we got, and we have now essentially completed the Pacific Missile Range as far as the basic tools are concerned. These are radar, timing, telemetry, communications, range ships and aircraft, optical instrumentation, photography, data collection and data reduction. All these are now finished or well along toward completion. So you can say that PMR is essentially complete as far as basic tools.

Now of course, we re-orient all the time as we get new major projects like *Nike-Zeus.* This causes us to do a lot of re-orienting, spend a lot of money for new facilities . . . and this is our life. Every month that goes by, I would say, we get these new projects. This usually requires new facilities, as well as all our old facilities. We look forward to these new projects all the time, and we are always in a flexible situation.

In such a situation, however, it's difficult to look ahead too far. But we have a very enthusiastic, very aggressive and very "can-do" outfit, which can, because of its flexibility, take care of these short-notice major projects. We like to have as much previous notice as possible, of course. The range is a tremendous service agency put here by DOD to assist in the testing of missiles, getting satellites into orbit, getting space projects off the ground, and getting space probes up and recovered.

We're just a big service organization, that's all we are. If it weren't for the major projects that are assigned here, there would be no excuse for having a range like this.

"When we have a 10,000 mile missile, we will go that far . . . At present, we stop at Atlas . . ."

Q. *Would you comment on the extension of the Pacific Missile Range?*

A. Essentially, in working with Atlantic Missile Range and White Sands Missile Range, we cover the world. AMR and PMR meet on parallel 90 west, and the continental United States is handled by White Sands.

The length of any range is determined by the range of the biggest missile it fires. Our largest one to date is the *Atlas*, so we go down as far as the *Atlas* range. When we have a 10,000 mile missile, we will go that far, but at the present time we have no such missile so we stop at the *Atlas* range.

We are also establishing various stations around the world to get the *Transit* satellite program operational. As

(Continued on page 40)

The Missile/Space Week

X-15 Nears 2000 MPH at Half Throttle

North American's *X-15* rocket plane made its first successful flight with the 57,000-lb.-thrust engine last week. Shackled by his contract as to height and speed, pilot Scott Crossfield kept the drag flaps open and the Reaction Motors powerplant at less than half throttle during the 138-second run. Performance reports indicate that the ship hit almost 2000 mph and an altitude of over 65,000 ft. The second flight is expected this week and will probably involve checking out the engine's in-flight stop-start capability. Maximum-performance flights, expected to pass 4000 mph and 100 miles altitude, will take place when NASA assumes control of the ship.

AF Anxious to Press Space Plane

Look for the Air Force to push for at least $20 million in the FY 1962 budget to get its space plane program underway. The unboosted plane would be powered by a hydrogen engine and would scoop up its own oxygen from the atmosphere. Takeoff weight would be between 250,000 and 500,000 lbs. Lockheed, Convair, Douglas, Republic and North American are among companies already conducting design studies.

Moon Probe Hits Veldt

Two pieces of metal that fell on a farm in Transvaal, South Africa, Sept. 25 have been identified as pieces of the second stage of the ill-fated *Atlas-Able III* moon probe.

Telemetry sightings of the pieces indicated they fell from an altitude of 800 miles, the National Aeronautics and Space Administration said. One was a 3-ft.-diameter sphere, apparently a helium bottle used to supply pressure in the *Able*. The other was a piece of metal 28 in. long.

The flight program called for re-entry of the second stage over the Indian Ocean. However, in the actual flight, the *Able* failed to reach full chamber pressure and burned for only about 80 of the programed 110 seconds.

AF Builds Know-How at Vandenberg

The Air Force is building a "blue suit" technical capability for missile and space launches at Vandenberg AFB—a move expected to phase out much of contractors' work at the base. The ARDC field office at Vandenberg, designated the 6565th Test Wing, will be responsible for site activation, military test and evaluation and space launch operations. Site activation will include construction, installation of E780.3,5, checkout and technical assistance. The 6596th Instrumentation Squadron, a unit of the 6594th Test Wing (Satellite), Sunnyvale, Calif., will be attached to the Vandenberg Wing for operational control prior to and during launch for space booster operations.

Off the Pad

Another mid-air catch on Nov. 15 of an Air Force *Discoverer* capsule revived flagging hopes that the U.S. would orbit an animal in space this year . . . Recovery of another *Atlas* data capsule only 12 hours later after a 5000-mile flight will permit further evaluation of new nose cone materials. The AF missile withstood temperatures up to 12,000 deg. during re-entry . . . Later the same day an AF *Mace B* flew 1000 miles after a 24-hour "hot-hold" in its simulated underground hard site . . . The next day the Army's *Pershing* traveled 160 miles in the first fully successful flight test of the rocket's two stages.

Manned Ballistic Launch May be Off Until April

THE LATEST DELAY in th Project *Mercury* flight test progran may have pushed the first mannec ballistic launch back to April, 1961.

Another attempt may be made thi week to launch the first *Mercury Redstone,* scheduled originally for the da before Election Day. The shot wa called off because of a leak in the capsule attitude gas system. The capsul was taken down from the launch pa at Cape Canaveral for a complete tes of the gas system, which took mor than a week.

If all goes well with the *Mercur Redstone* series once it begins, primate is to be carried on the secon and a man on the third. But even wit the best of success, a period of les than two months between launchings i considered highly unlikely.

Meanwhile, the *Mercury Atla* series continues to stretch out. Januar is now considered the likely date c the second *Mercury Atlas* (MA-2 which will test how the McDonne production capsule will withstand r entry at a sharp angle. This experimer was programed last July for MA- the first of the series, but the *Atlas* e ploded.

Officials of the National Aer nautics and Space Administration r port the MA-2 shot is delayed by decision to use a final productio capsule. An R&D capsule was used i the July test.

One official voiced hope that t test rate will accelerate after the ne two hurdles. Four McDonnell produ tion capsules are on hand at the Ca now. Two are intended for *Redsto* shots and two are for *Atlas* shots. T others have been launched.

The number of *Atlas* shots befo the manned orbital attempt has nev been stated officially, but one sem official guess is about seven.

Inevitably, the lengthening time r quired is adding to the total bill. T first guess was $200 million for t overall program. Officially, the N tional Aeronautics and Space A ministration now puts it at $350 m lion. Some Congressional sources nc feel the total may hit $500 million.

Hydrid, Liquid Systems Added to ARPA Program

Project *Principia,* the Advanced R search Projects Agency program f uprating solid propellants, will broadened to include hybrid and liqu rocket systems. The broadening dc not necessarily mean any increase expenditures. Some avenues for upr ing solids 10 to 20% have reach dead end and will be abandoned.

HAY...

A meadow—
of no military significance.
Not far away a vital military area.

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A convoy arrived
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The defence requirement changed
Thunderbird moves rapidly to where next needed
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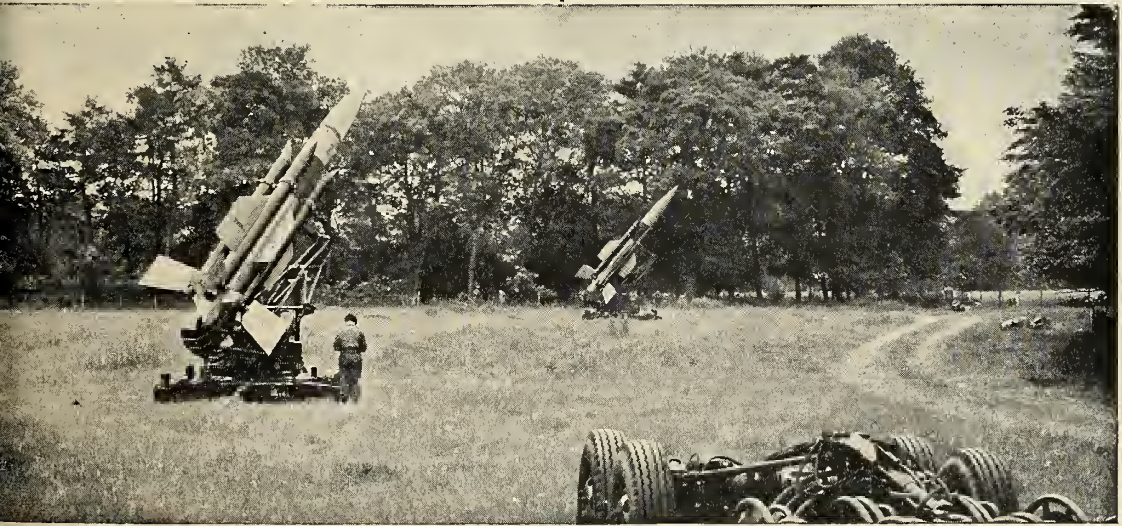

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Technical Countdown

ELECTRONICS

New IR Scanner Developed

A display-type infrared scanner, called Avscan, has just een developed by Avco Electronics and Ordnance Div. Good for detection of aerodynamically heated bodies up to everal miles distance, the system is small and lightweight 40 lbs.). It uses four nitrogen-cooled indium antimonide junction type) detectors and rotating refractive optics. These scan with a resolution of 0.1° by 1°.

Exotic Power Sources to be Studied

General Electric will study precise output control of nconventional power sources under a new Navy conract. Study is aimed particularly at so-called "exotic" power levices: thermionic converters, thermoelectric generators, nd fuel cells.

More Fuel Cell Progress

A proof-of-principle liquid-metal fuel cell developed by Allison Div. of General Motors has been operated coninuously for up to 1 hour. Current research at Allison is lirected toward producing efficient final configuration 1/10 he size of existing prototypes but with same power output.

First Mail Relayed by Satellite

The first "space mail" was relayed last week via the *Echo* satellite between Washington and Newark, N.J. The Post Office's traditional Christmas message—"Shop and Mail Early"—was converted to facsimile, transmitted to the atellite by microwave, reflected back to earth, and reconerted back to its original form. Approximately 5 minutes vere required for the complete process.

GROUND SUPPORT EQUIPMENT

Mistram Construction Bids Due Soon

Army Corps of Engineers is expected to open bids early next month totaling $1.5 million for construction of facilities or Cape Canaveral's precision trajectory system (Mistram). Work is scheduled for completion by Sept. 15, 1961.

Atlas Guidance Sites Completed

The last of the scheduled radio-guidance sites for the AF *Atlas* ICBM was finished and turned over to SAC last week t Offutt AFB, near Omaha, Neb. Other installations are t Vandenberg AFB, and Warren AFB, Cheyenne, Wyo.

Thermoelectric Generator for Weather Station

Bureau of Standards has awarded a contract to General nstrument Corp. to build a propane-fueled thermoelectric enerator for a Navy automatic weather station in the Gulf f Mexico. The unit is scheduled to run for one year on 25 gallons of propane to power the meteorological instruentation and telemetry transmitter installed in the unanned station.

Gas Turbines for Pershing GSE

First gas-turbine support units for the Army *Pershing* ave been shipped by AiResearch. Comparable to the dual ower units used by commercial jets, the turbine package rovides all missile ground power requirements for aironditioning, ac and dc power, and high- and low-pressure neumatic power.

Electric Crane Loads Titans

Titan ICBM's can be unloaded and positioned in firing silos within a few minutes with a new electrically-controlled no-clutch crane developed by Unit Crane and Shovel Corp. A remote unit within the silo provides the precise control necessary for positioning the missile within the extremely close tolerances of the silo.

PROPULSION

More Aerobee Shots Planned

NASA plans a series of *Aerobee* sounding rocket shots from Wallops Island to test the properties of liquid and gaseous hydrogen mixtures under zero-g conditions. Information to date has come from Air Force-NASA experiments in KC-135 aircraft out of Wright-Patterson AFB.

Ion Rocket Test Slated

First ion rocket flight-tested will be a tiny device powered by less than 200 lbs. of batteries. The first test will raise the question whether any impulse at all is possible—since ground tests cannot demonstrate the possibility of beam neutralization.

Repeater Satellite Brood Scheduled

Multiple launching of active repeater communications satellites may be tested in a *Centaur*-boosted package in 1963 or '64. Under tentative NASA plans, 8 or 10 satellites would be spewed out of a big carrier each time it hit apogee of an elliptical orbit. Each satellite would have a small propulsion unit to make its orbit nearly circular.

Electrical Propulsion Proposed

Marquardt Corp. is proposing a plasma diode powerplant for spacecraft that would provide 300 kw by direct conversion from a nuclear reactor, bypassing the turbogenerator phase in current systems. Marquardt's design study indicates the system would weigh only 1050 lbs.

ADVANCED MATERIALS

Allison to Develop MM 2nd-Stage Cases

Aerojet-General awarded a development contract for second-stage *Minuteman* steel cases to Allison last week. The GM Division is already deep in first-stage case work.

Temperature Rise Induces Magnetism

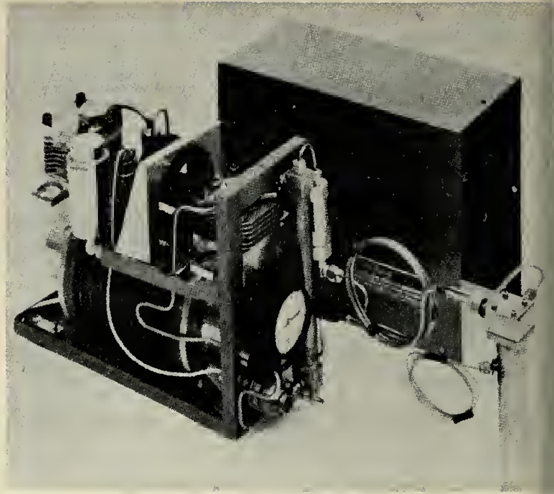
DuPont has come up with metallic compounds that become magnetic as their temperatures rise above a point predetermined by their chemical composition. Chromium manganese antimonide was the first compound discovered. The magnetic switching is controlled by the amount of chromium.

Polymers Improve in Space

Goodyear scientists say that those molecules which do "boil" away in a vacuum frequently leave behind an enhanced polymer. Ultraviolet radiation also may prove beneficial since the break caused by it is made permanent by oxygen fusing to the end of the chain. There being little oxygen in space the chains can re-combine to form strong, or possibly stronger, polymer structures.

Closed-Cycle Coolers for Space

Air Products' cryogenic units are light and small enough for use in satellites and vehicles



COMPACT CRYOGENIC cooler developed by Air Products Inc., is shown with compressor (left) and heat exchanger (right)

by Charles D. LaFond

CLOSED-CYCLE CRYOGENIC cooling systems that are lightweight and compact enough for satellite and space vehicle applications soon will be available for broad use.

Prototypes of an entire family of such units have been under test for many months at Air Products, Inc., in Allentown, Pa.

Rugged and reliable, these closed-cycle coolers have been needed for some time for cooling infrared detectors at liquid nitrogen temperature (77°K) and for cooling down to the narrow range of 15° to 35°K, using liquid hydrogen or neon. For both ground and space vehicle use of parametric amplifiers and MASER's there is a need for cooling down to liquid helium temperature of 3.5°K.

All of these low temperatures can be obtained quite readily under laboratory conditions, but what has not been available in the past is a means for doing this automatically and under "normal" working conditions. Normal could mean an isolated or unattended radio or radar station or space vehicle.

Problems still exist in the development of such systems for space use—primarily that of heat disposal—but research by Air Products so far indicates that these too will be solved shortly.

Engineers at the company's laboratories have been working on the whole problem of cryogenic cooling for the past three years. The current closed compressor-type systems developed have been under test for six months. These have successfully endured 100- and 500-hour test runs without failure.

Principal devices tested which may meet space needs of the future have been Joule-Thomson expansion systems using hydrogen or neon. These provide 0.5 to 2 watts useful refrigeration in the 15 to 60°K range. Auxiliary refrigeration has been supplied below the inversion temperatures of the two gases either by an independent Joule-Thomson expansion circuit of nitrogen or by an external supply of liquid hydrogen.

The Joule-Thomson effect system was selected by Air Products because it offers lower thermodynamic efficiencies than those refrigeration systems employing expansion engines.

Simplicity and compactness were equally important characteristics.

The system is comprised basically of two parts—the Joule-Thomson heat exchanger and the compressor. Helically finned tubes coiled around mandrels are used for the compact exchanger.

High-pressure gas flows inside the tubes; low-pressure gas flows outside the tubes in combined counter- and cross-flow heat exchange.

A variety of exchangers have been built and tested, varying in size from ¼-in. to ¾-in. dia. with flow rates from 0.1 to 1.0 scfm of hydrogen. To reduce radiation heat-leak, the cold end of the exchanger employs a copper radiation shield. This is maintained at roughly liquid nitrogen temperature.

Filters are used within the high-pressure fittings in the head of the exchanger for protection against foreign matter which might otherwise block the small exchanger tubing.

The compressors employed are two-stage, non-lubricated, completely enclosed units.

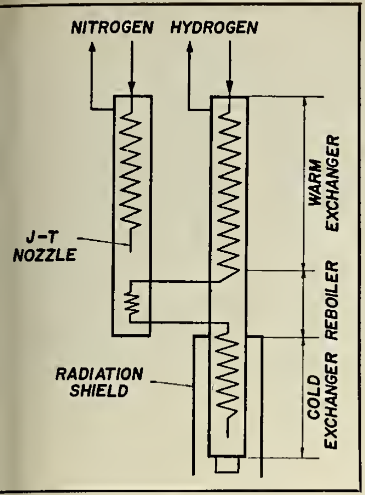
• **Performance**—Cool-down time (the time required to reach liquid stage) in any cryogenic cooling system is extremely important. In the series of exchangers currently undergoing tests the following typical results were described in a paper presented before the Infrared Information symposium in Boston by two of the company's engineers, P. K Lashmet and J. M. Geist:

1) For a ¼-in.-dia. x 5-in.-long exchanger, cool-down time was 5. minutes for nitrogen operating at pressure of 2250 psig and a flow rate of 0.34 scfm. The same time resulted with hydrogen at 1800 psig and a flow rate of 0.37 scfm.

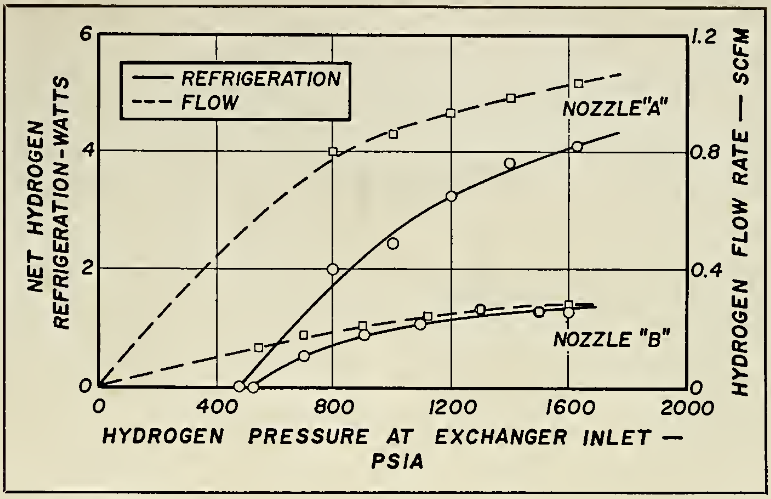
2) For a ¾-in.-dia. x 13-in.-long exchanger, cool-down time was 22 minutes for nitrogen at 2000 psig with flow rate of 1.28 scfm. The same time resulted with hydrogen at 1500 psig and a flow rate of 0.74 scfm. Since most of the refrigeration during cool-down is required to reach liquid nitrogen temperatures, cool-down time depends largely on nitrogen pressure and flow, and is affected only slightly by the hydrogen pressure and flow. Data obtained with the ¼-in.-dia. heat exchanger and presented in the last graph accompanying this article show thi effect. In these tests the nitrogen and hydrogen operating pressures were applied to the exchanger simultaneously.

Since the negative Joule-Thomson effect of the hydrogen requires refrigeration, the times presented in the figure are reduced by allowing hydrogen to pass through the exchanger at low pressure during the initial cool-down.

Cool-down times of four minutes said Lashmet and Geist, have been obtained for the ¼-in.-dia. exchange with initial hydrogen pressure of 20 psia and nitrogen pressure of 2200 psia If optimum cool-down times are required in a detecting system, the necessary control circuit could be incorporated. Cool-down times calculated from the estimated refrigeration capacities allowing for heat-leak and warm end



SCHEMATIC FLOW *diagram of a hydro-gen heat exchanger.*



NET HYDROGEN *refrigeration at various pressures and flow rates (as a function of hydrogen inlet pressure).*

emperature difference, ranged from 50% to 90% of the measured cool-lown times, the engineers reported.

The differences are believed due to ncertainties in estimating the variation n flow-rate during cool-down, the heat-eak, and the temperature distribution n the heat exchanger.

• Temperature control—Close tem-erature control is maintained, when perating in the boiling liquid region, y supplying the gas at a pressure bove the minimum required for the efrigeration load. The inventory of iquid increases in the bottom of the xchanger until the excess refrigeration apacity is balanced by the increase in varm-end temperature difference.

Since the pressure drop on the low-pressure side of the exchanger is small, the slight variation in pressure drop will result in a negligible change in temperature. (In the region of the normal boiling point of hydrogen a temperature change of 0.01°K corresponds to a pressure change of 0.05 psia.)

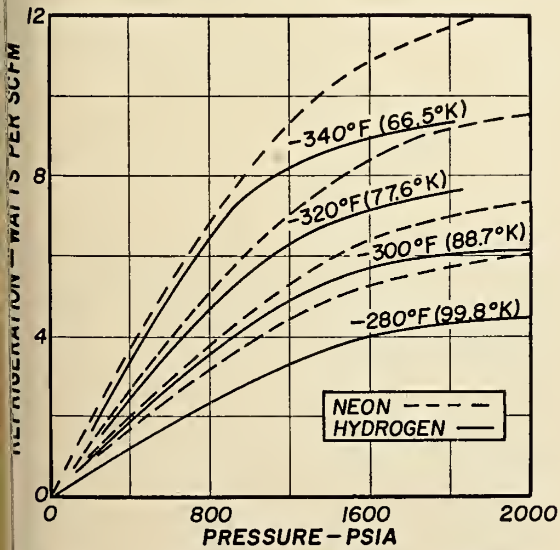
If the heat-load should increase suddenly, a liquid inventory is available for maintaining the cold temperature while the exchanger is adjusting itself to the new condition. This self-compensating behavior insures a stable cooler despite moderate variations in the heat load. This was verified, said the two engineers, during the tests for determining the net refrigeration, since cold temperatures were maintained during large variations in the loads.

When operating the heat exchangers at temperatures above the critical point the refrigeration supplied by the exchanger must be balanced with the heat-load requirements of the system, since there is no self-compensating liquid reservoir.

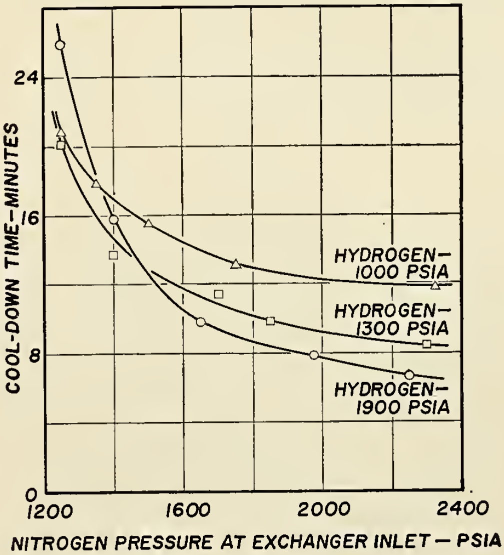
The heat capacity of the dense gas is small compared with the latent heat of the liquid and the system is less stable when subjected to changes in heat-load. The heat capacity may be increased by adding metal to the cold end.

Several methods for controlling the refrigeration to balance the system have been considered by the Air Products engineers and tried in preliminary investigations: (1) control of the inlet hy-

(Continued on page 25)



HEORETICAL *capacities of Joule-Thomson exchangers as* nction *of temperature and pressure at inlet to unit.*



COOL-DOWN TIMES *for a ¼-inch-diameter exchanger at various* N_2 *and* H_2 *operating pressures.*

Hot-gas 'Servos' Are Ready For Design into Missiles, Vehicles

- ***An expert report on the direct-energy control system now in use on six R&D missiles.***
- ***Why valves determine which servo is best for a specific application***
- ***Which parameters are involved in the selection of a type for a given job***
- ***How the units offer advantages in weight, low cost and high reliability—if proper propellants are chosen***

by Charles Delson

Applications Engineer
Armament and Control Section
Light Military Electronics Department
General Electric Co.

HOT-GAS SERVOS are ready to be designed into missiles and spacecraft, providing a direct-energy means for controlling weapon systems vehicles.

The term "servo" is a misnomer in this instance. A servo is usually understood to be a means for providing control with some type of closed loop for reduction of error.

A better name is "hot-gas control system," because it includes both open and closed loop types of control and may be expanded to include additional hot-gas-driven components such as turbo-alternators and gyros, as well as gas-generating components and the electrical amplifier, feedback, and compensating networks.

The *Sidewinder* was the first U.S. missile to use hot-gas servos. It is still the only missile in quantity production with hot-gas servo control. But now at least a half-dozen missiles in research and development use such servos—for example, the advanced *Sidewinder, Mauler, Shillelagh, ARM* (Anti-Radiation Missile) and the *Bullpup Trainer.*

• **Picking the right servo**—The servos can be separated into three broad categories according to valve types. The problem areas of the actuators, the propellant, and the amplifier and feedback networks are important considerations; but it is primarily the valves that have the greatest effect in matching servos to application.

1) The on-off type—sometimes referred to as the Flicker, step-type or bang-bang.

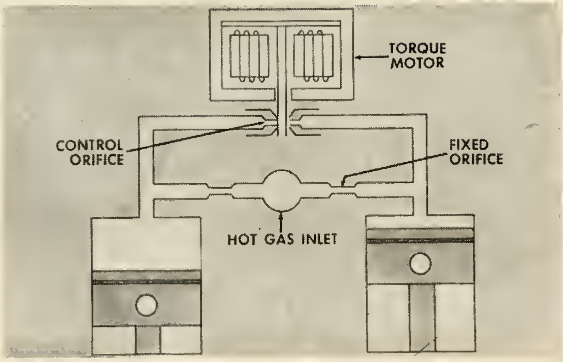
2) The single-stage proportional type—sometimes referred to as the open-center proportional type.

3) The two-stage proportional type—sometimes referred to as the closed-center proportional type.

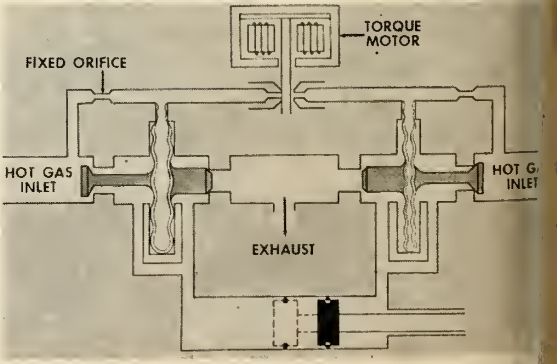
The usual approach in applying a control system is to try to use the simplest type system that will give th desired performance with the highes reliability. The simplest type hot-ga servo system is the on-off type. Ther are several versions of the on-off control that can be tried with a chose vehicle. They are the two-position control, three-position control, five-position control, torque-saturated contro and time control.

If the on-off control should prov to be unsatisfactory, the next approac is to try the single-stage proportiona type control. Generally, on this typ the flow rate is always the same n matter what torque output is require and the control is therefore not conservative in the use of the gaseou energy products.

An evaluation should be made wit this type of control to determin whether a straight proportional or puls modulating type is the more satisfactory. Although the pulse modulatin type is slightly more complex in th design of the driving amplifier, it ca operate for a longer period because



SINGLE-STAGE hot-gas servo valve schematic.



TWO-STAGE pressure control valve.

Bell's All-weather Automatic Landing System—symbolized.

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Bell brings this goal one important step closer with its All-Weather Automatic Landing System (ALS) which can fly two airplanes to touchdown every minute, even when visibility is absolutely zero.

The Bell ALS takes over when the pilot brings his plane through the electronic "window in the sky" and guides it to a safe and sure landing.

The system has been flight-proved in more than 4,000 landings with all types of aircraft—small private planes as well as airliners from the DC-3 and DC-7 to the huge Boeing 707 jet. It now is being evaluated at FAA's National Aviation Experimental Center, Atlantic City, N. J.

Unlike other automatic landing systems, the Bell ALS is ground-based so a ground observer monitors every approach and landing. It can operate either fully automatically or under pilot control.

Military versions of the ALS have been ordered by the Air Force. The Navy has selected it for installation aboard the nuclear-powered aircraft carrier USS Enterprise as well as for its other large carriers.

The Bell ALS is but one among many contributions which Bell Aerosystems Company is making to the scientific progress and defensive strength of the free world. We invite qualified engineers and scientists to inquire about sharing our challenging and rewarding future.

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Advantages of Hot-Gas Servos

FOR SHORTER RANGE MISSILES:

1) Light weight because the energy source is used directly for providing the power output.
2) Long duration storage capacity.
3) Low cost as demonstrated on the SIDEWINDER missiles.
4) High reliability as demonstrated on the SIDEWINDER missiles.

Reference is made to the SIDEWINDER missiles because they are the only missiles that presently use hot-gas servos in large production quantities; and the reliability and low cost of these missiles are some of their primary attributes.

FOR LONGER RANGE MISSILES AND SPACE VEHICLES:
(With Proper Choice of Propellant)

1) Operational capability in the high temperature environment.
2) Operational capability in a radiation environment.
3) Operational capability for long periods of time such as would be required in space travel.

Proper choice of propellant implies the use of not only monopropellants such as hydrogen peroxide, hydrazene, ethylene oxide, and N.P.N., where hot gases from products of decomposition are used for reactive or actuation power, but also some bi-propellants as well as such liquids as Freon, acetone, ethyl acetate, and anhydrous ammonia, whose vaporized gases can be used for minute attitude reaction control on long flights through space.

the dithering effect on the flapper. It also will hold null to a greater accuracy than a straight proportional type because the flapper position does not determine the output torque. It is only the differential dwelling time between one nozzle and the other that will determine torque output.

The final control valve is the two-stage type. In spite of greater complexity, it has worthwhile advantages. The bleed rate across the first stage is very small in relation to the flow rate required for power output. This is an important point in the conservation of gaseous energy. The second-stage bellows design provides a large area high-gain pressure sensitivity. For very small differential position of the first-stage flapper valve, the bellows will provide an immediate control. This increased gain provides greater capability in obtaining higher frequency response.

• **Setting Parameters**—The question now arises as to which of these particular types should be used for a particular application. For this comparison, refer to the Table.

Consider the parameter of response—for an on-off type control, response is the rate of movement of the control surface or nozzle under certain loading conditions. A response rate of 250° per second can be readily attained. However, it is well to note that in the analysis of many on-off control systems, this is much too fast.

The response for proportional controls pertains to frequency response. The response of 10 cps for the single-stage control is the closed-loop frequency response indicated by a Bode plot where the drop-off becomes larger than 3 db.

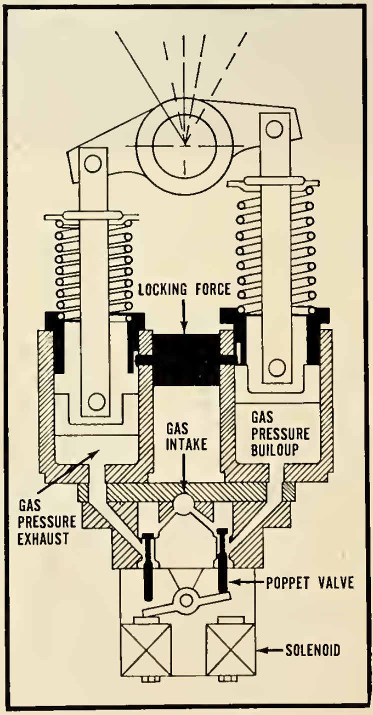
Frequency response flat out to 10 cps on single-stage and 15 cps on two-stage proportional control can be readily obtained. A torque loading of 800 inch-pounds, inertial loading of 0.1 in.-lb-sec^2 and a hot-gas supply pressure of 1000 psi are used as a common reference across the chart. Increasing the supply pressure increases the response capability of the servos above these rates; however, having a large coulomb friction content in torque output has an adverse effect on response.

The next design parameter is length of operating time with solid propellant. Solid propellants were chosen because of the contamination in the exhaust gas products. It has been G-E's experience that propellant exhaust gas products always contain a considerable amount of ash or carbon and it is only the fineness of these particles and their tendency to adhere to each other and surrounding structure that varies between manufacturers. If certain liquid propellants were used as a design parameter, the length of operating time would be increased considerably and temperature of the gases would then become the main limiting factor.

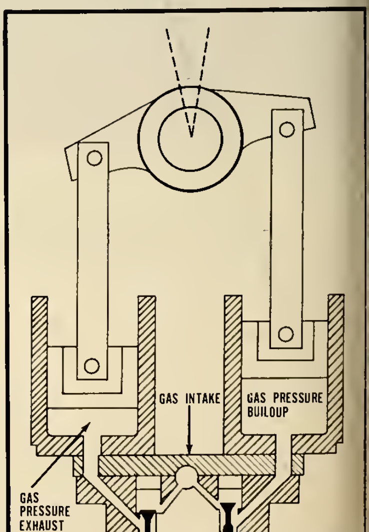
The Table shows that the on-off control will operate for a period of approximately 10 minutes with solid-propellant gases. This period could probably be extended further if it were practical to install longer burning-time grains. Still, a 10-minute grain is about 30 inches long and is quite cumbersome in its packaging requirements.

The length of operating time of a single-stage proportional control with solid propellant is limited to approximately two minutes. This time may be increased somewhat by using a pulse modulating type of circuitry which has a tendency to break the contaminated particles from the flapper valve and blow them through the system. On the two-stage proportional control, the operating time is somewhat under two minutes with exhaust products of solid propellants. The tightness of orifices and the criticality of materials make a two-minute operating period seem quite long.

The next design parameter is production and development costs. If a number 1 were placed on the on-off



FIVE-POSITION discontinuous control valve is one version of on-off unit.



TWO-POSITION discontinuous control valve. On-off control offers most simplicity

Table of Comparison of Servo Designs

Item	On-off control (Flicker, 2, 3 or 5 position)	Single-stage proportional controls		Two-stage proportional control
		straight proportional	pulse modulating	
Response	up to 250°/sec	10 cps	10 cps	15 cps
Operating time with solid propellants (min.)	10	2	2+	2–
Production and development cost (relative to on-off control)	least (1.0)	slightly higher (1.25)	higher (1.5)	highest (5–6)
Max. torque motor differential current (ma)	80	20	20	15
Fixed orifice dia. (in.)	.....	0.018	0.020	0.008
Control orifice dia. (in.)	0.060	0.036	0.044	0.025
Control orifice stroke (in.)	0.007	±0.0045	±0.0045	±0.002

control, the single-stage proportional control would be approximately 1.25. The single-stage pulse modulating control would be approximately 1.5; and the two-stage proportional control would be somewhere around 5 or 6 because of the complexity of design and manufacture.

The next design parameter is the current required for operation of the coils and torque motors. The on-off control can be readily designed to draw 80 milliamps from a 24-volt source. The current draw is dependent on the voltage available, the valve stroke and seat diameter required to provide proper flow rate, and the weight and size limitations on the coils. On the single-stage proportional control the differential maximum current draw is 20 milliamps. On the two-stage proportional control valve, the differential current draw is 15 milliamps because of the inherent larger gain within the valve.

Other design parameters are fixed orifice diameters, and control orifice diameters and strokes. By looking at the Table, one can readily see why the length of operating time becomes more critical with the proportional valves with respect to the on-off valves and why the cost of these systems is increased. ⁂

Miniaturization Contest Open for Nominations

The 1960 Miniaturization Awards Committee is receiving nominations for its fourth annual competition.

The "think-small" award—sponsored by Miniature Precision Bearings, Inc. honors the individual or organization who has made the year's outstanding contribution to furthering the concept of miniaturization. Winners are chosen by an independent committee of experts from industry, government, and the technical press.

Last year's winner was David A. McLean, Bell Labs, for his sputtered tantalum technique in producing microminiature components and circuitry. Previous winners were The Martin Co. (for development of SNAP 3), and Diamond Ordnance Fuze Labs (for use of photolithographic processes and printing techniques in producing transistors).

Information for entrants, and other data on the awards program is available from W. Hutchinson, Box #604, Keene, N.H. Entries for the competition must be submitted not later than Jan. 10, 1961.

Navy's 'Wobbler' Designed For Accurate Hole Measure

The Navy has developed a device for measuring the diameter of small holes (on the order of 0.2-in.-dia.) to an accuracy of 0.0002 in.

The "Wobbler" was designed at the Naval Ordnance Lab, Silver Spring, Md., to determine within a half percent the amount of explosive contained in small-diameter test fixtures.

Simple in design, the device is basically a cylinder attached to a rod, connected to a dial. The cylinder, with a diameter slightly less than that of the hole to be measured, is inserted in the hole of the test fixture and the rod is rocked or wobbled by hand. As a function of the size of the hole, the movement of the rod is measured by the dial, which indicates the diameter of the hole to within two-tenths of a mil.

The "Wobbler" is being used by the Explosion Dynamics Division of NOL's Explosions Research Department to determine hole sizes in explosive test fixtures.

Closed-Cycle Cooling

(*Continued from page* 21)

drogen gas pressure; (2) control of the refrigeration supplied by the nitrogen circuit; and (3) the addition of an internal heater. Of these methods, the two men believe the third offers the most promise, provided that a sufficiently sensitive temperature sensor and control circuit is used. Additional work is being conducted for control of refrigerant gases, at temperature above critical points.

- **Future uses**—A multitude of uses exist for good closed-cycle coolers. An infrared crystal that must operate at liquid nitrogen temperature could of course simply be immersed in a dewar of liquid nitrogen during the laboratory or testing stage of its application. While this type of system can be used in several actual applications where the dependence on a supply of liquid nitrogen or other fluid is not a problem, more advanced systems are needed for extended operating time.

The chief merits of the Air Products closed cycle system are that it is lightweight, compact and self-sufficient —in that it needs no supply of cryogenic liquid or gas. Therefore, it can be used for space or airborne applications, various types of antenna applications, and other situations requiring these features.

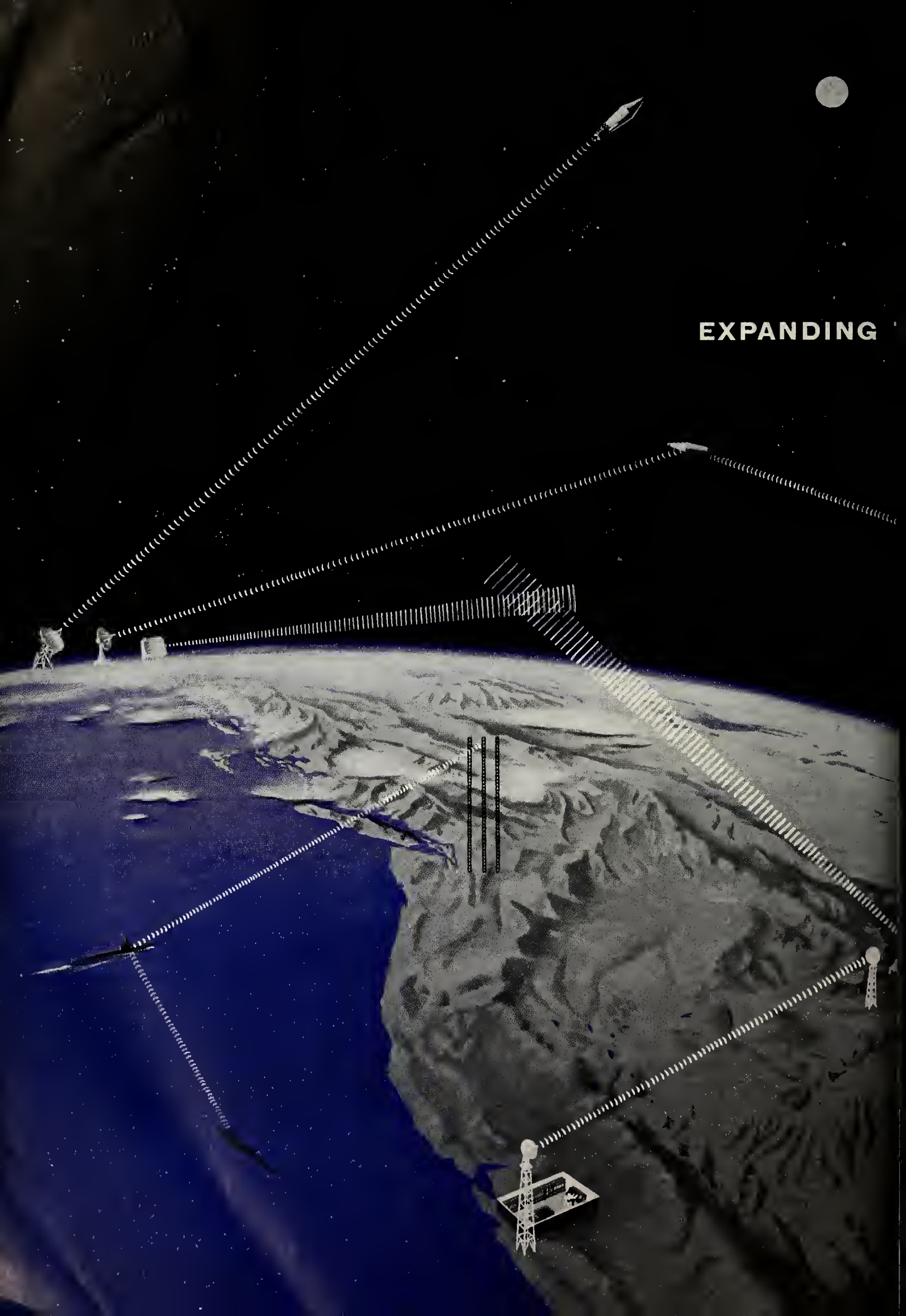
Airborne applications would include infrared detection systems and parametric amplifier radar systems. IR detection devices are used for surveying and detecting, and in the operation of fire control systems. Parametric amplifiers are used to increase the sensitivity of existing radar systems.

Antenna systems, both ground based and airborne, using parametric amplifiers or MASER's, will also use a closed cooling system. By mounting such a compact system on the antenna, the long supply lines or system of joints required with a more conventional system are avoided.

Ultrasensitive MASER's are being used on advanced radio telescope work for detection and communication. During the recent Project *Echo,* signals were received at one installation by a MASER system that was immersed in an open dewar of liquid helium.

This type of system will be replaced eventually by a closed cycle system.

Satellite and space vehicle communication is another important area where the closed cycle system may find wide acceptance. Since high sensitivity can be achieved on the ground with such receiving devices as MASER radio telescopes, the size and power of the sending equipment carried in such a vehicle can be greatly reduced. ⁂


EXPANDING

Herodotus, the historian, records (490 B.C.) the use of burnished shields for military signaling. This was the forerunner of the heliograph, invented by Sir Henry C. Mance, which came into wide use centuries later.

ONTIERS OF SPACE TECHNOLOGY IN COMMUNICATIONS

Lockheed's interest in developing the science of communications extends from the depths of the oceans to deep space. Its Missiles and Space Division research programs deal with the development and application of statistical communication and decision theory in such areas as countermeasures; telemetry multiplexing and modulation; scatter communications; multiple vehicle tracking; millimeter wave generation and utilization; sonic signal detection and processing; avoidance of multipath degradation; and interference avoidance.

Associated research and development efforts are directed toward propagation studies and advanced antenna design; low noise amplifiers; vehicle borne signal transmission and reception, data storage and processing; solid state materials and devices.

The scope of such activities extends from advanced studies of naval communication problems on and under the oceans; the many applications to satellite vehicles; on to the specialized communication problems of deep space explorations. Latter needs are exemplified by high frequencies, low weight and power, high stability, low effective bandwidth, extreme reliability and basic simplicity requirements.

Engineers and Scientists: Investigating the entire spectrum of communications is typical of Lockheed Missiles and Space Division's broad diversification. The Division possesses complete capability in more than 40 areas of science and technology — from concept to operation. Its programs provide a fascinating challenge to creative engineers and scientists. They include: celestial mechanics; communications; computer research and development; electromagnetic wave propagation and radiation; electronics; the flight sciences; human engineering; magnetohydrodynamics; man in space; materials and processes; applied mathematics; oceanography; operations research and analysis; ionic, nuclear and plasma propulsion and exotic fuels; sonics; space medicine; space navigation; and space physics.

If you are experienced in work related to any of the above areas, you are invited to inquire into the interesting programs being conducted and planned at Lockheed. Write: Research and Development Staff, Dept. K-29B, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed / MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM; the Air Force AGENA Satellite in the DISCOVERER, MIDAS and SAMOS Programs

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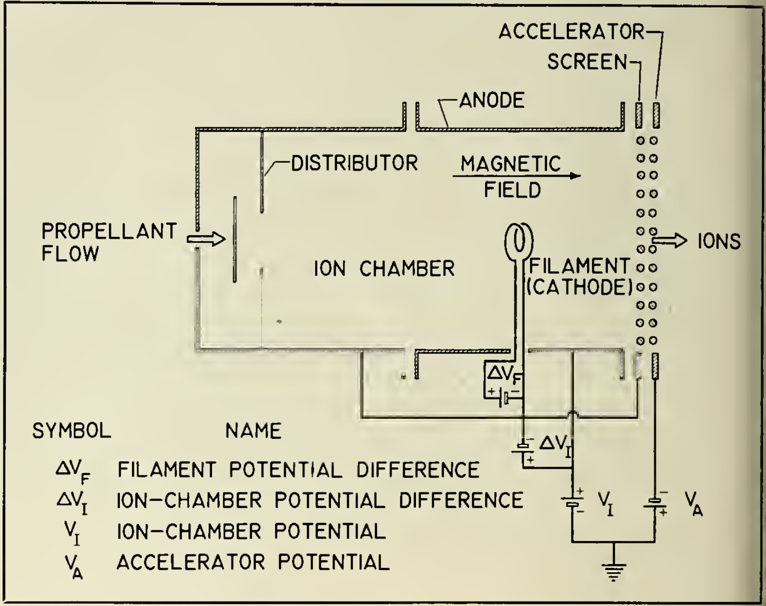
A Stride Forward in Ion Motors

NASA reports sharp improvement in performance of units powered by electron-bombardment sources for total of 50 hours



SYMBOL	NAME
ΔV_F	FILAMENT POTENTIAL DIFFERENCE
ΔV_I	ION-CHAMBER POTENTIAL DIFFERENCE
V_I	ION-CHAMBER POTENTIAL
V_A	ACCELERATOR POTENTIAL

SCHEMATIC DIAGRAM of the ion engine with electron bombardment ion sources operated by scientists of the National Aeronautics and Space Administration.

MONTEREY, CALIF.—Bright prospects for ion motors using electron-bombardment ion sources are reported by scientists who operated two such motors with more promising results than had been previously attained.

The work was reported by Harold R. Kaufman and Paul D. Reader, of the Lewis Research Center of the National Aeronautics and Space Administration. They told the Electrostatic Propulsion Conference of the American Rocket Society here that NASA has operated two ion motors using mercury fuel for a total time of about 50 hours.

The motors used 10-centimeter-diameter ion sources and obtained a power efficiency of about 70%, a propellant efficiency of over 80%, specific impulse of 5500 seconds, with an ion beam current of 0.125 ampere.

Although some at the conference felt that the electron-bombardment method is not yet as practical as porous tungsten ionizers, they were pleased that the NASA work had produced such favorable results.

The conference was described by many members as one of the most useful of its kind, because of the very high content of scientific information—"instead of the usual batch of sales pitches in the form of technical proposals," as one member put it.

- **NASA's system**—In theory, the NASA engines have a gaseous propellant entering through a distributor, and subsequently ionized by high-velocity electrons in the 20 to 100-volt range, emitted by a hot filament. Screen, distributor, and negative end of the filament are operated at the same potential, so that an electron emitted from the filament should not go to either end of the ion chamber.

A magnetic field parallel to the axis prevents the high-velocity electrons from reaching the wall without first colliding with particles in the ion chamber. Some of the ions that are formed pass through the screen at the downstream end of the ion chamber and are accelerated to become the beam.

With the ion chamber filled with a plasma, high velocity electrons are injected into the plasma to ionize neutrals, but the bulk of electron density would be composed of electrons with a velocity too low to ionize many atoms.

Performance of the second of the two engines was markedly better than the first, which was mainly an effort to evaluate the ion source. The first was operated for 10 hours and the second for 40 hours.

The first engine, running at ion beam currents from 0.01 to 0.06 ampere and specific impulses from 3200 to 5500 seconds, operated as follows, with beam current at 0.060 ampere:

Specific Impulse: 4500 seconds

	Volts	Amperes	Watts
Magnetic Field	12	15	180
Filament	8	6	48
Ion chamber discharge .	50	1.5	75
Accelerator Impingement	3000	.010	.30
Ion Beam	2000	.060	120
Total			453

Specific Impulse: 5500 seconds

	Volts	Amperes	Watts
Magnetic Field	12	15	180
Filament	8	6	48
Ion chamber discharge .	50	1.5	75
Accelerator Impingement	4000	.017	68
Ion Beam	3000	.06	180
Total			551

The overall power efficiencies of the two points on the performance scale (beam power divided by total power) were 27 and 33%. Propellant flow rate for both points was equivalent to 0.075 ampere, indicating a propellant utilization of 80%.

The second engine differed from the first in the wire grid material, which was tungsten instead of stainless steel; the wires were left free at the ends to allow for thermal expansion without warp; insulators were shielded from a direct view of the ion chamber to prevent short circuits resulting from deposits; and the magnetic field coil was changed to give a more axial field with more turns used to reduce associated power loss.

Accordingly, the second engine operated as follows:

Specific Impulse: 4500 seconds

	Volts	Amperes	Watts
Magnetic Field	7	5.7	40
Filament	7.5	6.0	45
Ion chamber discharge .	50	1.85	92
Accelerator Impingement	3500	.0015	5
Ion Beam	2000	.100	200
Total			382

Specific Impulse: 5500 seconds

	Volts	Amperes	Watts
Magnetic Field	7	6.7	47
Filament	5.2	6.2	32
Ion chamber discharge .	50	1.7	85
Accelerator Impingement	4000	.0032	13
Ion Beam	3000	.130	390
Total			567

NASA says the biggest single factor in the performance increase was a reduction in the magnetic field coil loss, although reduced impingement current and improved ion chamber performance aided in the improvement.

Overall power efficiencies for the two performance points shown were 52 and 69%. Propellant flow rate was equivalent to 0.158 ampere, so that propellant utilizations were 63 and 82%.

Although only mercury was used as a propellant in the tests covered, NASA emphasized that the engine can use many types of fuel.

• **Multiple beam motors**—As many as 19 ion beams from a single motor have been achieved by Electro-Optical Systems, Inc., according to a paper presented by four members of the company, M. P. Ernestene, A. T. Forrester, R. C. Speiser and R. M. Worlock.

The multiple beam systems are seen useful where "practical thrust levels" must be produced. Configurations operated include circular porous tungsten ionizers mounted in close packed hexagonal arrays. Accelerating and decelerating electrodes had corresponding multiple circular apertures. The porous tungsten ionizers were back-fed from a cesium vapor supply system controlled by a needle valve.

Thrust from an aperture emitting 3000-volt cesium ions corresponding to a specific impulse of 6600 seconds, is 34 micropounds at most, according to the EOS group. Higher voltages can produce more thrust, but it is not considered possible to get useful thrust levels from a single aperture for the voltages which can be reasonably expected for ion motor application.

• **Improved materials**—Progress in fabrication of large-size porous tungsten components for ion engines has been achieved, with resulting components measuring 5 inches in diameter by ¼-in. thick, according to Semicon Inc.

L. J. Cronin, the firm's president, said it has also produced small beam-forming discs of porous tungsten which can be joined to refractory metals by a brazing technique developed at Semicon. He said other developments include an "S" cathode with a lower work function than conventional electron emitters of the tungsten dispenser type, intended to aid the neutralization problem in ion motors. ⌘

space medicine

Astronaut to Get Tasty Food

DINNER IN SPACE may not be the *specialité de la maison* at Antoine's, but it still may beat the blue plate special at Joe's.

Air Force diet specialists agree that the astronaut's food may be just as important psychologically as it is nutritionally. Good hot meals will have to compensate for the cigarettes, wine and women he left behind.

ARDC's Lt. Col. Albert A. Taylor, assisted by Beatrice Finkelstein and Robert E. Hayes, has come up with a menu with such delicacies as:

–Oatmeal topped with sugar and cinnamon, coffee and bread for breakfast.

–Sliced turkey, roast beef sandwiches or spaghetti for lunch.

–Veal, turkey or beef in chunk form, with mashed potatoes or rice, buttered green vegetables for dinner.

–Cookies and fruit at every meal.

A much more economical diet in terms of weight, space and power supply can be achieved by the use of "food bars," Col. Taylor points out. But a "high level of acceptability" feeding plan will produce a more effective astronaut.

A well-varied diet for an intermediate duration flight—3 days up to several months—can be planned with canned, dehydrated and instant foods.

Additional water for food preparation will bring the water requirement to about 2500 to 3000 milliliters (almost 3¼ quarts) a day for a two- or three-day trip.

A water tank for 9000 milliliters would weigh about 23 lbs. and occupy 0.4 to 0.5 cubic feet. Studies are under way on a water heater weighing about 5½ lbs.

The now familiar squeeze tube studied in weightless maneuvers would be used for packaging and serving food. Rectangular aluminum cans to which water can be added will probably be used for dehydrated foods. Meat solids will be wrapped in bite-size chunks and stored in cans.

• **Longer flights**—Journeys lasting several months will require a partly closed ecological system recovering waste water. Col. Taylor ups the water requirement to 5000 milliliters (about 5¼ quarts) on longer voyages, since an additional 2000 ml. will be necessary for hygiene purposes.

A small, suitcase-type electric oven and a thermoelectric refrigerator are being studied by the Air Force for use in the "most desirable food plan." Again, weight requirements will dictate the calibre of the food.

Several of the big food packagers have pushed the space food drive with the idea that a new packaging method could bring commercial dollars. The TV dinner can be partly attributed to—or blamed on—the extensive Air Force studies for hot meals for long-range bomber flights.

• **Closed system studies needed**—"The next step, is to develop the closed ecological system," says Col. Taylor.

"Closed ecological systems must be brought out of the basic research stage by beginning applied research. We will need at least a concentrated 10-year effort to develop a workable system.

"Twenty-five percent of the work can be accomplished by in-house effort within government institutions and 75% under contracts with universities, non-profit organizations and industrial firms," the ARDC Biomedical Chief estimated. ⌘

First 'Space Kitchen' To Be Delivered in April

The Whirlpool Corp., home appliance manufacturer, has received a contract from ARDC's Wright Air Development Division for development of a "space kitchen."

The experimental model, to be completed in April, 1961, will be designed for an area about 10 feet long by 7½ feet in diameter. It must accommodate a three-man crew on a 14-day mission in a multistage rocket.

Appliances in the kitchen will include a miniaturized, thermoelectric refrigerator and a freezer, a three-cavity oven and a 2½-gallon water system with its own heater. They will be used to heat or dispense food prepared before flight.

Air-free water will be provided by a manually operated positive-displacement pressure pump. The kichen will be equipped with support handles to aid the astronaut in maneuvering in the weightless condition.

The pilots will eat one at a time, and will have to strap themselves down in their chairs. Food will be squeezed from containers into the pilot's mouth.

When he is through, he will "wash the dishes" with specially prepared cloths. Waste will be deposited in self-sealing disposal sections and sprayed with an antiseptic solution.

Space Dominates Hydraulics Meeting

DETROIT—The solution of hydraulic problems in space follows the approach taken in a murder mystery, but with two major differences—seldom is there a "corpse" or a "scene of the crime."

If you're lucky, says M. Ogman, Senior Design Engineer of Convair Astronautics, you may have a mutilated corpse to examine; missiles occasionally explode on or near the launching site.

But the Convair scientist told the 10th Annual Aircraft Hydraulic Conference recently that all you usually have left is a farewell message recorded back on earth as pen scratchings on a piece of paper.

Ogman pointed out that no *Atlas* failure had ever been attributed to malfunction of the hydraulic system—yet this does not imply a perfect system.

This is because less and less telemetry is assigned to a system as more and more confidence is placed in its performance.

The most common error on the part of the designer-turned-investigator arises from inability to rationalize a sequence of events to fit the conditions that have occurred.

The meeting, sponsored by Vickers Inc., Division of Sperry Rand Corp. heard Ogman outline a plan to create failure tests on a system level using missile simulators already in existence. Such data would greatly assist any future flight failure investigation.

Some possible areas of interest included: Complete or partial loss of accumulator precharge, complete or partial loss of reservoir pressurization, system performance with air in the oil, system performance with controlled external oil leakage, and loss of variable-volume pump pressure compensation.

Ogman pointed out that he had compared frequency responses of servo actuators on the *Atlas* simulator with a properly bled system and then with the system infiltrated with measured amounts of air. At the conclusion, one could not determine which system had the air.

• **Heat barrier**—High-temperature hydraulics was discussed by W. Bobier of Vickers. The hydraulic-fluid feasibility tests have reached 1000°F with the development of the polyphenyl ethers by Shell Development Laboratories. The main problem in high-temperature hydraulics revolves around the sealing aspects.

Studies in this field were reported by S. Cannizzaro of Republic Aviation, who said that although the solution is still being sought Republic's efforts have developed at least part of the answer.

A two-part paper compared battery, hot gas and inertia wheel power supply systems for short-duration vehicles. The first part was presented by H. Howard and H. Markarian of Vickers.

The two scientists compared the systems for a booster assuming a three-stage missile, each stage with a 60-second operating time and the computer gyro's and instrumentation power equal to 1 KVA of precision AC power for 180 seconds. Servo actuator amplifier power requirements was set at 50 watts of either AC or DC during the operating time of the individual stage.

A bleed gas AC system emerged as the most promising because it has the lowest effective weight, 100% check-out reliability, excellent achievable reliability and maximum operational temperature range—and its weight does not increase if the missile booster rocket engine firing duration is increased.

Having selected the bleed gas AC system, the experts went on to describe, in greater detail, a system using an integrated hot-gas motor AC generator. The presentation was made in two phases—one consisting of the operating mode when the system is airborne, the other the operating mode when the system is being periodically checked out with ground power.

The second part of the paper dealt with an inertia wheel power supply for a hypothetical manned space vehicle. N. M. Fruktow and J. J. Ventura of Space Technology Laboratories, Inc., briefly treated the history of flywheels and the general types available.

Advantages and possible disadvantages were listed. The STL experts proposed an inertia wheel auxiliary power supply for all boost stages, and these could be hydraulically, electrically or ram air pneumatically energized.

In the vehicle coast phase, the wheel system would stop delivering hydraulic power after third stage burnout and provide only electrical power. This continues for two hours, after which the re-entry phase begins.

The authors concluded that the ram air type inertia wheel is the most suitable system for the re-entry phase an summarized ram air turbine and scoo duct designs.

Two vernier solo flywheel second stage AP systems were considered. I one configuration a single unit, used a motor and pump, changes from on function to the other at sustainer cut off. In the second configuration th motor and pumps are separate units both connected to the flywheel. Th flywheel is accelerated by the sustaine hydraulic system.

According to Fruktow and Ventura there is no essential difference in th operation of the two configurations bu the separate motor and pump systen has a definite edge with respect to reliability.

• **Desert tragedy**—The effects o long-time storage on hydraulic components is of interest in connectio with the deployment of ICBM's in underground silos. A. B. Billet, senio staff engineer at Vickers' Aero Hydraulics Division, concluded that long term silo storage would present no foreseeable problems if humidity and temperature are controlled ". . . in th presently planned manner."

Billet's conclusion was drawn fror a study of hydraulic components afte 17 years' exposure in the Libyan Desert These parts were removed from th ill-fated B-24 "Lady Be Good," discovered in 1959 by an oil exploratio crew.

Many types of equipment were recovered in duplicate and this made i possible to test one piece as-is whil disassembling and inspecting a simila part as-is. The method reduced the possibility of introducing error whicl would occur if the same piece wer tested and then inspected after such long period in an adverse environment

All hydraulic units had an excellen coating of oil and met the efficienc requirements of new units. A check o a quart sample of recovered standar red hydraulic fluid led to a belief tha only minor deterioration had occurred

Other papers covering the missil field included hydraulic designs aboar the *Polaris* and *Minuteman* missiles Kurt Stehling of NASA spoke on spac vehicle operations and design considerations. Attitude controls developments at Vickers were described by Dr. W. W Chao.

1960 NOVEMBER 1960

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
	1	2	3	4
5	6	7	8	9
10	11	12	13	14
15	16	17	18	19
20	21	22	23	24
25/30	26	27	28	29

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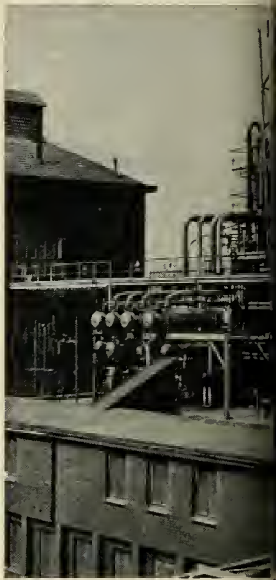
European Propellants Work Dra

Mutual advantages of sharing research developments and markets create affiliations in Italy, Germany and elsewhere

ROCKET propellant press (at left) of BPD's Explosives and Ammunition Division at Colleferro. The Italian firm is a major maker of double-base solid propellant.



SOLID FUELS could be made at Farbenfabriken plant (at right) now producing

"ALL ROADS LEAD to Rome," but missile industry officials who have been there recently are familiar with one road that passes on through Rome and wends its way 30 miles south to the modern, spotless, and wealthy suburb of Colleferro.

This planned, garden-type community of 15,000 people is one of the European missile industry's most important centers, organized, financed, built, and occupied by Societa' Bombrini Parodi-Delfino—Italy's huge chemicals-muntions-solid propellants complex.

Almost every day, one or several American missile and propellants industry officials make the side trip to still-expanding Colleferro. There they can make contacts, pick-up information and—as several U.S. firms, including Aerojet, already have learned—form affiliations. Bombrini Parodi-Delfino (BPD) is headquartered in Rome (Via Lombardia No. 31) and has a branch office in Milan; but it is to Colleferro that Americans make their way.

Colleferro, the complete "company city," is an example of BPD's self-reliance. So is the company's attitude toward rocket production. Parodi-Delfino produces all components—fuselage, fuses, propellant—and assembles a 50 mm air-air rocket in Colleferro. It has just finished testing a second small rocket that will be produced entirely at Colleferro and marketed, it hopes, in the U.S. as well as throughout Europe. It is a unique design by BPD. Nozzle offsets produce a rifled rotation of the fuselage, while the fins remain stationary. The fins are attached to an outer band separated from the fuselage by ball bearings. Of course, it uses a BPD solid propellant.

The company is interested only in solids, no liquids, and is particularly well-known in double-base technology. In the last year, it has devoted much effort to the composite powder field. BPD is an industrial leader in gunpowder and munitions, cement, insecticides, and synthetic textiles. In every case, everything is produced at Colleferro—from raw materials to finished product. Besides production facilities, BPD maintains at Colleferro a complete static test station, automated where possible, and equipped throughout with closed-circuit TV. Until recently, the station could accommodate only the 50 mm air-air rockets. However, an expansion to handle larger sounding rockets is being carried out.

BPD is basically an industrial chemicals firm, but Americans who talk with Dr. Alvaro de Orleans Bourbon, member of the board of directors, or with Dr. A. Cereseto, Director of Development, come away convinced that propellants will play an increasingly important role in Bombrini Parodi-Delfino's plans.

• **How U.S. firms benefit**—Colleferro is but one stop on a route that is travelled more and more by U.S. missile people. Some American chemical officials say they feel that they are on a commuter circuit with Paris, Rome, Geneva, Frankfurt, Essen, London, and their home offices.

Why this new interest in European propellants?

American firms are finding advantages—one of them is rapidly be-

S. Firms

by S. David Pursglove

lastics intermediates. Company has five major locations, 50,000 chemical workers.

coming a necessity—in affiliating with European firms (M/R, Oct. 24). It gives them an opportunity to supply propellants needed in Europe's own mushrooming defense and sounding rockets programs, supply U.S. missiles n Europe, and cash in on an expected ncrease in European propellants research. It helps to be on the scene, hrough European affiliates, in order o better adjust to the increasingly important Common Market and Free Trade bloc concepts of business.

• **Dividends for Europeans**—The European firms are looking forward to he arrival of U.S. firms. Europe especially welcomes American know-how and facilities in high-energy fuels—an area virtually unexplored in Western Europe until now. European companies eek affiliations with U.S. firms for everal reasons, including these:

–The growing number of NATO missiles and the Defense Department's increasing insistence that propellants for U.S. forces be produced in Europe is straining European capacity: more U.S. money, know-how, and hardware is needed if this demand is to be met.

–European governments are just now getting interested in high-energy propellants—both for their own rockets and for new U.S. missiles expected in Europe within a few years; affiliations with U.S. companies in this area can save European firms time and money.

• **Another Italian entry**—Italy is not the only country moving ahead in propellants, and BPD is not the only Italian firm interested in the Space Age. Another company interested in Europe's rocketry expansion, especially in high-energy fuels, is Larderello, of Pisa. This company is Italy's major supplier of boron. It has rights to Europe's only significant native source of boron, the mineral geysers near Pisa.

Larderello at present furnishes only boron compounds for industrial use. However, it is developing important contacts with possible users of boron derivatives in H-E fuels.

• **Germans active**—Europe's other major boron supplier is Suddeutsche Chemische Werke, a German company wholly owned by Stauffer Chemical Co. (M/R, Oct. 24). SCW has no local source, but imports crude borates from Stauffer's U.S. plants, and refines them as borax, metallic borates, and boron fluorides.

Stauffer is also affiliated with the German firm Degussa, one of the companies that developed Europe's centrifuge process for uranium isotope separation. Degussa licenses Stauffer's electron beam furnace process for producing nozzles as well as other rocket components.

At least two other German firms are strongly interested in rockets: Wasag Chemie, Essen, which is working in H-E fuels; and Telefunken, Berlin, which has a piece of the hardware program for *Hawk* (BPD leads in the propellant end of *Hawk*).

The huge German chemical industry represents one of Europe's major sources of propellants. However, the big chemical companies are quiet about their interest in propellants; some vigorously deny any interest at all (but send representatives to meet with U.S. missile principals at the embassy in Washington).

It's hard to blame the companies, however. There is strong pressure in Germany to avoid munitions publicity and ward off the "merchants of death" tag that has attached to the German chemical industry in the past.

The enormously effective I.G. Farben cartel, forced to split following World War II, would be Germany's best provider of propellants if it were reassembled. Such a hope is not vain. Gears are kept oiled in Bonn and Frankfurt to bring I.G. Farben once again under central direction if it is ever required. The four major successor companies are autonomous firms, but they keep in close touch. They are: Fabrike Hoechst, Badische Analin und Soda Fabrik (BASF), Farbenfabriken Bayer, Chemische Werke Hüls.

• **Wide inventory**—Among the propellants that they and other German firms can supply, or already deal in heavily as industrial chemicals are:

–Alcohol—BASF, Hoechst, Degussa (which is strongly interested in propellant grade alcohols, and is considered a propellants firm).

–Analine—Bayer (BASF would not be a major supplier despite the company's name).

–Hydrogen Peroxide—Degussa, Kali-Chemie Hanover, Merck, Riedel de Haen, A.G. (Hanover), Dr. Theodor Schuchardt GmbH & Company (Munich).

–Hydrazines—Bayer, Schuchardt.

–Oxygen—Hoechst, Chemische Werke Hüls, Bayer.

–Perchlorates—Riedel de Haen, Schuchardt, Merck.

–Boron Compounds—SCW, Riedel de Haen.

These companies can supply propellants intermediates. Whether they are willing is another matter. However, Germany is not without its rocket interests, even though production and most R&D is conducted in other countries. One American chemical company official says: "The Germans are 'bootlegging' their scientific level rocket work." This is mostly physics and some applied research on hardware, with little effort going into propellants.

At least one extra-national German research effort is centered in Laboraboire de Récherches Techniques, St. Luis, Heiut-Rhim, France. This is a joint German, French and Italian group seeking new techniques in missiles and propulsion.

• **Elsewhere in Europe**—Switzerland, too, is "bootlegging" some rocket and missile research. The country is neutral almost to the point of aggressiveness: Although it conducts aircraft research within its borders, it feels that neutralism calls for most of its missile interests to be pursued in other countries. This is done through foreign subsidiaries, such as the Italian affiliate, Contraves-Italiano (part of the Orlikon group).

France and England, partly because of their closer ties with the U.S. and certain missile-oriented internal politics, are special cases. They are making new moves in the field of rocket propellants, and there are some advantages for affiliation with French and British firms. These countries and North Europe will be treated later in M/R. ⌘

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F.A.I. Rules Put Russians on Spot

Soviets may have to release secret rocket data or forfeit chance to qualify for world records in space contest

by Bernard Poirier

NEW REGULATIONS for estabishing world records in outer space iave been made by the International Aeronautical Federation and if the JSSR sticks to the rules, it appears ikely the secrecy barrier on Soviet ocket data may be broken.

In establishing the new records, the F.A.I. (Fédération Aéronautic Internaionale) stipulated that:

–"The flight plan must be submitted o and be approved by the F.A.I. prior o the record attempt."

–"The contest event, in its entirety, nust be verified as to the accuracy by nstrumentation, on the ground or in he vehicle, sanctioned and approved by the F.A.I."

–"The vehicle component reaching he maximum performance and in which a pilot has been present from the nitial thrust at the earth surface posiion must return to the surface at the earth with the pilot (astronaut) alive."

Since Russian space rockets have been closely associated with their CBM development, it seems that Russia will balk before complying. However, because of her propaganda gains based on rocket achievements, she may still capitulate in order to get official ecognition—lest she be suspected of heating or exaggerating.

A record recognized by the F.A.I. will enhance the prestige of any chievement in space. If, for example, he U.S. establishes a record, she at once gets recognition from 48 member ountries, including Russia, plus four ssociated groups in Guatemala, India, outhern Rhodesia, and Cuba.

All NATO countries and all Comnunist bloc nations, except East Gernany and Red China, are members. The remainder are from Latin America, Africa and Asia.

Russia has often claimed F.A.I. world aviation records through its member organization. All members, includng Russia, "must accept and apply hese new rules" on World Space Records said F.A.I. Director General H. R. Gillman.

With this background in mind and emembering the fact that the F.A.I. has had a reputation for honesty among member nations since its inception in 1905, it would seem almost dishonest for a member to start recognizing only politically acceptable F.A.I. regulations. This could be the case regarding space records.

• **Bill of specifics**—Russian policy could be seriously shaken by the clearly expressed rules requiring that supporting documentation be submitted and certified on such "details" as:

–Advance notice that an attempt for record will be made

–Type of rocket engine(s) used

–Power (Thrust) of the engine(s)

–Number of engines

–Date of Launching

–Time launching will take place

–The location and name of the launching site

–Report on boosters to assist liftoff or other special apparatus installed to assist control and landing.

–Evidence and report of any accidents

–The weight of the vehicles and appropriate parts

The F.A.I. membership has supported and accepted the organization's regulations. Having concentrated its rocket propaganda towards neutral or noncommitted nations, Russia finds herself in an international organization whose membership is composed by a majority of so-called neutral and noncommitted nations and whose regulations are diametrically opposed to its policy of secrecy. At this time it is obvious that Russia cannot conform to the rules and maintain its policy.

World Records now available can be claimed on the basis of Duration of Flight, Altitude without Earth Orbit, Altitude with Earth Orbit and Greatest Weight lifted 62 miles (100 km.) or more.

New records will be established. Mr. Gillman said, "at any meeting of the Committee called especially to consider new types of record, specialists on the subject will be invited to attend."

Smaller countries can compete and even succeed for some of the records. Every country on record for having performed rocket achievements within some of the necessary parameters have official membership in the F.A.I. All have access to the new Space Rules listed in Section 2.A of the famous F.A.I. Sporting Code. The rules pertain to vehicles propelled by rockets.

Today's principal competitors are represented by the Aero-Club Federation of Australia, the Royal Canadian Flying Clubs Association, the National Aeronautic Association of U.S.A., Aéro-Club de France, the Royal Aero-Club of the United Kingdom, Nippon Koku Kyokai, and Aéro-Club Central de l 'U.R.S.S.

Headquarters for the Fédération Aéronautique Internationale is in Paris. The President is M. J. Allez, First Vice President is Dr. W. Muri, the Director General is H. R. Gillman and the Treasurer is M. J. Blériot.

A Frenchman, a German and a Belgian are credited with suggesting the creation of the Federation during their attendance at the Olympic Congress in Brussels on June 10, 1905. ⌗

West Germans Appoint Space Research Advisers

BONN—The Aeronautical Advisory Board of the Federal Ministry of Transport has constituted a committee to advise the ministry on all problems arising in connection with space research and exploration.

Members of the Committee for Space Research are: Prof. Bartels, Director of the Institute for Physics of the Stratosphere, Göttingen; Prof. Ehmert, department head of Max-Planck Institute for Aeronomics, Lindau/Harz; Prof. Goercke, Technical University, Stuttgart; Prof. Graul, University of Marburg; Prof. Pascual Jordan, University of Hamburg; Prof. Dr. Kienle, University Observatory, Heidelberg; Prof. Dr. Moeller, University of Munich; Prof. Dr. Quick, Technical University, Aachen; Prof. D. Roessger, Technical University, Berlin; Prof. Dr. Saenger, Research Institute for Physics of Jet Engines, Stuttgart; Prof. Dr. Strughold, U.S. Air Force School of Aviation Medicine; Dr. Gerlach, Deputy Chairman of DGRR (German Society for Rockets and Space Research).

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soviet affairs

By Dr. ALBERT PARRY

Rocket Boss Nedelin's death
was announced by the Soviet government on Oct. 25 in the close-mouthed way the Red information service usually reveals such top-level accidents. The world was told that Marshal Mitrofan I. Nedelin was killed in a plane crash—and this terse word followed by only four days the Moscow news that Colonel General Nikolai Pavlovsky, a Soviet armed forces staff officer, had died in the line of service. There was much eulogizing of both men, but no further details of either accident.

Was some rocket-launching failure
of considerable dimensions connected with the two (or perhaps more) deaths? We know that in September and October Nikita S. Khrushchev stayed in New York longer than he had originally planned. We can surmise that the premier's American stay was not lengthened because he was deeply engrossed in United Nations affairs. It is plain that Khrushchev postponed his departure from our shores because he was waiting to get spectacular tidings of his rocket men's achievements while he was on United States soil—so as to make his visit here truly triumphant.

But no news of a successful man-into-space experiment
flashed to Nikita during his New York sojourn, and finally he left for home—in a hurry, taking a plane instead of his slow ship *Baltika*. On landing in Moscow he may have been quite stern to Nedelin and other Soviet high-bracket missile-and-rocket men. Responding to such talking-to, Nedelin and his immediate entourage may have tried to expedite matters by an overly pressing and personal supervision of rocket launchings. Something or other, in addition to Kremlin tempers, may have blown up in their faces. Perhaps this is how those two top-ranking lives were lost, and possibly a few more than just those two—of Nedelin and Pavlovsky.

Nedelin had prepared for rocketry
by his long and successful service in Soviet artillery. I will not repeat his colorful career story here—the reader will find it in my column on page 45 in MISSILES AND ROCKETS of June 13 last; also, in more detail, on pages 136-137 and 149 of my book *Russia's Rockets and Missiles,* just published by Doubleday & Company of New York. Both these sources shed light also on the organization of Russian rocketry.

What interests us in addition to Nedelin's completed career is the personality of his successor as chief of Soviet rocketry, Marshal Kirill Semyonovich Moskalenko. Commander of the Moscow garrison for the last several years, the new rocket-marshal does not appear to have any special rocketry or even artillery preparation for his fresh appointment. Now 60 years of age, Moskalenko is an oldtime infantry man. In World War II he commanded first a rifle corps and then an army, chiefly in his native Ukraine, whence he drove the Nazi invaders across the Carpathian Mountains into Czechoslovakia. A Communist Party member since 1926, Moskalenko advanced in the Party's hierarchy simultaneously with his military promotions. In 1956, when he was made marshal, he was also elevated to the important Moscow Regional Party Committee and a month later to his membership in the Central Committee of the Communist Party.

A rocket expert
that would be less of a Party man and more of a new-generation scientist-warrior could have been appointed to the latest vacancy in Soviet rocketry by Khrushchev, but was not. The fact is that Khrushchev and his Party oligarchs, while using young military technicians intensively and skillfully, do not trust them for those top rocketry posts where they could make (or help make) policy. Hence the appointment of Old Man Moskalenko who, like Old Man Nedelin before him, is a zealous Party-line marshal, and has far less specific rocketry knowledge than the late Nedelin possessed. ⌘

—industry

ENDIX-PACIFIC DIV. of The Ben-lix Corp. has broken ground for a mul-imillion-dollar electronics center on an 0-acre site in the Northern San Fer-ando valley. The first building to be onstructed will be used primarily for lectronic production, according to Ben-lix. An adjacent building will house the ivision's sonar testing facilities, in-luding a 500,000-gallon-capacity tank.

ARIAN ASSOCIATES has created a ew department to concentrate on mili-ary applications of magnetometry, the ilitary Magnetics Department. The ompany has also announced that Var-an has reached preliminary agreements or the merger of Eastern Industries nto Varian.

ONTROL DATA CORP. has estab-ished a Research Laboratory at St. ouis Park, Minneapolis, to conduct dvanced investigations in the digital lectronics equipment field.

LECTRO-TEC CORP. will build a 0,000-sq.-ft. plant on a 10-acre site in Vest Caldwell, N.J. The plant will con-ain a research area and a greatly ex-anded prototype engineering and pro-uction department for Electro-Tec's ine of precision electromechanical de-ices.

HILCO CORP. has formally dedicated s expanded facilities of the Sierra lectronic Corp. Division of the Com-any's Government and Industrial roup. Philco added 50,000 sq. ft. to s existing 35,000-sq.-ft. facility. In enlo Park, Calif., the company an-ounced it will expand its employment rom about 200 to nearly 500 em-loyees.

OLLINS RADIO CO. has formed a ommunication and Data Processing ivision to provide electronic data rocessing services to industry. A $1-illion building to house the center is earing completion.

inancial

Marquardt Corp.—Sales of $51.1 illion for the 40-week period ended ct. 9 were reported, as compared to ales of $50.5 million the like 1959 eriod. Net earnings fell under the pre-ious year's period, $1.1 million com-ared to $1.3 million.

General Dynamics Corp.—A net ss of $25.1 million for the first nine onths of 1960 was reported, com-ared to a profit of $24.5 million the ke period last year. The company harged off all current and anticipated osts for the Convair 880/600 com-ercial jet program, totaling $61 mil-on.

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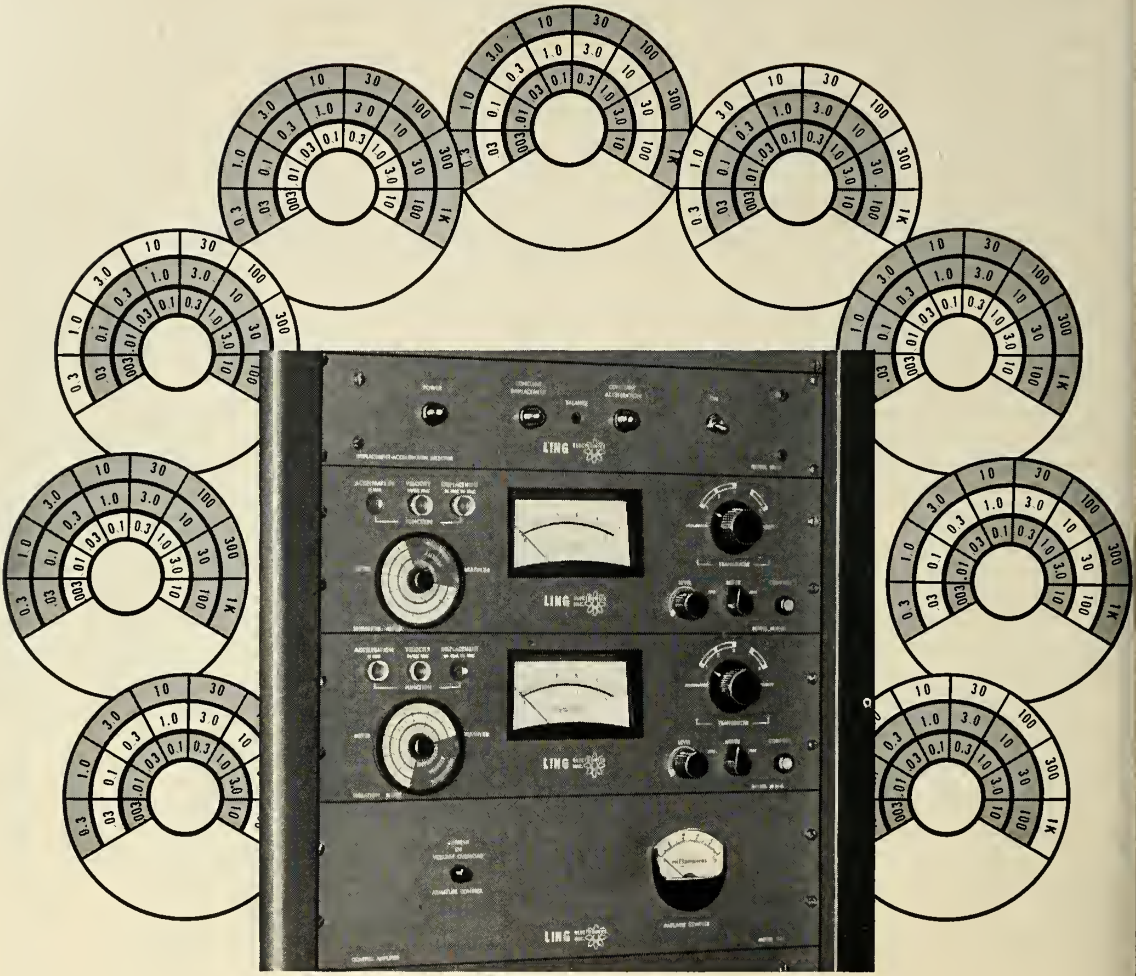

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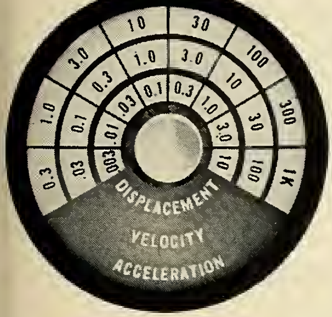

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Kennedy Expected to Work Closely with NASA Chief

PRESIDENT-ELECT KENNEDY is expected to identify himself closely with America's space activities.

Although there still is no hint as to who will be the new chief of the National Aeronautics and Space Administration, sources close to Kennedy and Vice President-elect Lyndon B. Johnson say the man chosen will be a close adviser to the President on space policy.

The situation will contrast with that in the present administration where NASA Administrator T. Keith Glennan has not been particularly close to President Eisenhower. Instead, Eisenhower has been guided by recommendations of his scientific advisers—first, James R. Killian, and later, George B. Kistiakowski.

• **New stress on prestige**—The effect of listening to scientists who were basic research-oriented, the new administration's advisers feel, has been a go-slow policy on space because of the high cost. It has been easy to persuade scientists that, from the purely scientific point of view, money is invested much more fruitfully in other, less expensive research areas.

The new administration will give much greater emphasis to prestige and possible military values of space exploration. As a result, possible conflicts between civilian and military aspects are expected to be the knottiest policy questions to be settled at the White House level.

One highly knowledgeable official predicted that a certain amount of duplication between military and civilian programs will be permitted as a lesser evil than taking a chance that either side might miss a good bet. But the same official declared that so expensive a duplication as *Thor* and *Jupiter* will never be tolerated by the new administration.

• **Modified council?**—It is the need for extensive policy guidance at the White House level that is reviving to some extent the Space Council, which was conceived originally as a permanent staff of up to 100 specialists who would advise the President and a council composed of Cabinet members, heads of government science agencies and a few non-government scientists.

Objections to the Space Council have centered on the fact that it takes up the time of the Secretary of State and others with a chore outside their field of interest. Thus, if something like the council should be retained, its structure might be modified, at least to the extent of authorizing members to be represented by deputies.

Whatever structure is adopted, advisers to the new administration feel that something should be established to help the President carry out the responsibilities given him by the Space Act of 1958. The act directs the President to:

–Survey all significant aeronautical and space activities, including the policies, plans and accomplishments of all government agencies.

–Develop a comprehensive space program.

–Fix responsibility for direction of major activities.

–Provide for cooperation between NASA and the military and specify which activities may be carried on concurrently by the two.

–Resolve differences among departments and agencies on space activities.

The act authorizes the President to appoint an executive secretary to be paid $20,000 a year and two top assistants at $19,000 a year exempt from the Civil Service laws. ⌘

ARS Seeks to Raise Dues To Meet Increased Costs

The American Rocket Society is asking members to vote on a proposed dues increase from $15 to $20 a year.

The ARS said the cost of servicing members has risen to a level of $66 a year. The difference is made up by revenue from advertising in the two society publications, Astronautics and the ARS Journal, and from exhibits.

Prior to the society's annual meeting in Washington beginning Dec. 5, members are also balloting on officers for 1961. Harold W. Ritchey, vice president and technical director of rocket operations for Thiokol Chemical Corp., is the choice of the nominating committee for president. William H. Pickering, director of Jet Propulsion Laboratory, Cal Tech, is the nominee for vice president.

Five directors will be elected from a slate of 10 put forth by the committee. They are: William J. Cecka Jr. of Rocketdyne, Robert A. Cooley of Chromalloy Corp., Prof. George Gerard of New York University, Prof. Samuel Herrick of UCLA, Robert H. Jewett of Boeing, Arthur Kantrowitz of Avco-Everett Research Laboratory, Bryon G. MacNabb of Convair-Astronautics, Simon Ramo of Thompson Ramo Wooldridge, Charles W. Williams of Chrysler Corp. and A. M. Zarem of Electro-Optical Systems Inc.

Highly instrumented aircraft . . .

(Continued from page 15)

you know, this is going to be the first operational satellite program, and will be the first satellite which will be usable by all the world, and PMR has the responsibility of establishing tracking stations for it.

Q. *Regarding your remark about the range of Atlas constituting the present limit of PMR, we understand that Titan II will have a range considerably in excess of present ballistic missiles . . . well beyond 10,000 miles. Presuming we would foresee range requirements, are we planning ahead to be able to track vehicles such as Titan II and Dyna-Soar over PMR?*

A. *Dyna-Soar* is being treated as a satellite. It goes around the world exactly as a satellite does, so you can't say *Dyna-Soar* has any particular range. So long as it stays in space, its range is a function of its speed.

"AMR gets far more data per firing than we do" . . . PMR's unconcerned between burnout and splash

Q. *Titan II, however, will reportedly have a range considerably in excess of what AMR can handle. Can its impact be accurately predicted and actually determined?*

A. I think you may be wrong about the range that AMR can handle. By shooting down between South America and Africa, they can handle any range that we are likely to put into a missile. As you know, they've demonstrated the *Atlas* at 9000 miles, and the range has another 1000 easily, because once they pass the tip of Africa, they have nothing but water ahead of them. So there's no limit to their range for R&D phases of a missile. Our firings out here are fo training and operational purposes.

Q. *However, we understood that the impact predictio on that Atlas was made from trajectory calculations and no from any actual impact information gathered at its terminus Now, if it's desired to check accuracy over such extrem ranges, isn't it necessary that some sort of definite splas net be set up?*

A. Well, they have a splash net in the Atlantic and the know exactly what the range is of each *Atlas* that has bee fired. They get far more volume of data from every firin than we do. They are interested in an R&D missile from th time it takes off, all through its trajectory, until the instan it hits. We at PMR essentially watch a missile only unti burnout and then we pick up the splash when it lands. I between these points, we don't pay any attention to it.

Q. *Does all your information come from hydrophon setups downrange?*

A. No, we have four very highly instrumented aircraf for airborne telemetry, airborne radar, communications beacon pickup and other things.

Q. *On the Nike-Zeus program, what facilities beside those at Kwajalein and Roi-Namur have been established?*

A. You really should ask the Army about this, but general answer is that, like any R&D program, the first fe months are spent testing components. The radar componen is being tested on the Atlantic Missile Range, where the can see the R&D shots coming downrange and get signature from them.

Q. *How do Nike-Zeus and Project PRESS (Pacific Rang Electromagnetic Signature Study) tie together, insofar a*

hey are both users of PMR and have adjacent interests?

A. That's the reason Project *PRESS* was put on Roi-lamur. It is a program to get electronic signatures from nissiles. The place to put them is where you get free targets o look at. So naturally, we located close to Kwajalein so hat we could look at all the targets that are fired at the *likе-Zeus* installation. This is so the radar operator can ook at the thing coming downrange and tell if he's looking t an ICBM, IRBM, a decoy, a satellite, or whatever it is. is expected that this will be quite possible, but we need lot of data.

Q. *When the Soviets fire rockets into the Pacific, we nderstand that your PMR facilities have provided impact ata on those shots. Can you comment?*

A. No, I can't comment on that. It would be very short-ghted of us not to use all the equipment we have, of ourse, to observe any firings in the Pacific. You could ex-ect that we would use all the equipment available.

lo commitments now for launching large oosters . . . but deep canyons could handle iggest thrust

Q. *In the same light, can you give any idea what the nge of the MILS (missile impact locator system) at PMR ations is?*

A. We build the MILS to handle whatever projects are n the range, and the range is sufficient to take care of erything from IRBM's to ICBM's. If we ever get a longer nge missile, we'll just extend the net. It's a very simple ocedure. The sound waves go all over the Pacific, so it's problem.

Q. *When the 1½-million-lb.-thrust rockets come along, ll Arguello have the launch facilities to handle them . . . e these launch facilities being built now?*

A. No, we're not building any right now, but we have set aside areas in which we could put not only 1½-million-lb.-thrust rockets, but six or ten million lbs. thrust or even greater. We have deep canyons there which have 2000-foot mountains surrounding them, making natural revetments against sound and explosions. These are ideal for large boosters. We are also keeping Arguello sanitized (devoid of permanent administrative facilities) so that when the time comes to put large boosters up there, as it undoubtedly will, we will be ready for them. As of today, however, we have no firm commitments and we are not doing anything but master planning.

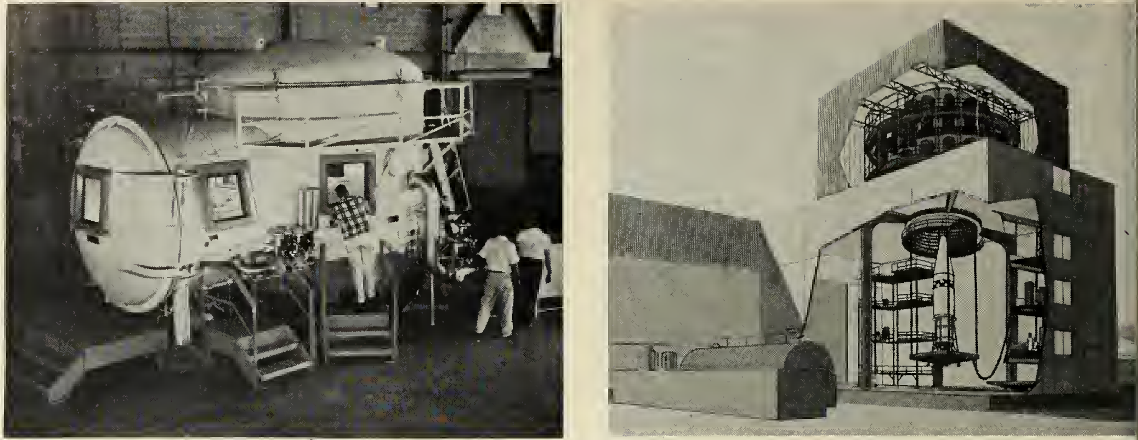
"When people ask me when the range will be finished, I reply that it will never be finished."

Q. *Does this include nuclear rockets? Could Arguello ground-launch a nuclear rocket?*

A. We could fire a nuclear rocket provided it is the second stage or higher. We wouldn't want to fire from Arguello with a first stage nuclear rocket. It's just too dangerous for the people in the area.

Q. *Do you have any further comments on the future of PMR?*

A. The thing I would like to leave you with is this: These ranges are never built and completed. We are always in the process of phasing in new projects and phasing out old projects. The new projects almost always require some new facilities or some increase in the instrumentation or better instrumentation. So we are always in a state of flux at these ranges, and when people ask me when the range will be finished, I reply that it will never be finished. We have all the basic tools now, but each project will need additional facilities, so that's our life. ⁂



SPACE SIMULATORS rise on East and West Coasts. At left is Tenney Engineering's high-altitude simulator for Project *Mercury* Astronauts at Cape Canaveral. At right is a cutaway drawin Lockheed's vacuum chamber to test big satellites like Agena.

Discoverer XVII 'Most Successful'

Los Angeles—Extended orbiting of the *Discoverer XVII* capsule before its mid-air recovery may yield new data on sunspot activity and the Aurora Borealis.

Intense sunspot activity occurred during the period in which the capsule was in space with instrumentation designed to record solar effects. Apogee was 615 miles.

"We let *Discoverer XVII* fly until the 31st pass—rather than bring its capsule down on the 17th pass as planned. *Discoverer* was functioning so well," Maj. Gen. O. J. Ritland, Commander of the Air Force Ballistic Missile Division, said.

Success of *Discoverer XVII* may mean the next *Discoverer* shot will carry a monkey into space.

Discoverer XVII, employing Lockheed *Agena-B* successfully for first time, was boosted into orbit by a Douglas *Thor* on Nov. 12. *Agena-B* first was used in the program on *Discoverer XVI* but failed to separate.

• **Second pass succeeds**—Aerial recovery of the gold-plated instrument capsule was accomplished Nov. 14 some 500 miles northeast of Hawaii by an Air Force C-119 piloted by Capt. Gene W. Jones.

The capsule floating down under a silver and orange parachute was first sighted at 30,000 ft. After an unsuccessful pass at 11,000 ft., the C-119 succeeded in hooking it at 9500 ft. The capsule, slightly scorched by re-entry, was flown to Lockheed's Sunnyvale, Calif., plant.

An Air Force announcement said: "From first orbit acquisition through re-entry and recovery, this has been our most successful operation in the *Discoverer* series. The capsule dropped right into the ballpark, in plain view of four C-119 aircraft."

Radio signals from the satellite vehicle were poor on its first polar orbit but later improved. Signal for capsule ejection was given for the first time by ground command. On previous *Discoverer* shots, this has been accomplished by a timing device.

• **Restart under wraps**—Gen. Ritland reported that *Agena-B's* space restart capability was not used on *Discoverer XVII.*

"But in future firings with more sophisticated systems," he said, "it will permit us to control a satellite's course to a much greater degree—and eve change its orbit."

Gen. Ritland discouraged spec tion that successful release of the c sule on ground command would lea satellite bombing systems. He no that the national policy does not c sider the use of space for offen weapons and added: "The problem keeping satellite bombers aloft— keeping them absolutely reliable long periods—would be tremendo

He acknowledged, however, tha similar recovery system will be u to recover reconnaissance data fr *Samos* satellites.

New Departure Using 'Cleanest Room'

Sandusky, Ohio—General Motors' New Departure Division last week began operation of its newest "clean room" for the assembly of precision miniature ball bearings.

Unabashedly calling the new facility "the cleanest place on earth," N/D says it combines the best features of all the newest such facilities in this country—and includes some unique ideas of the division's own.

All vertical walls are stainless steel or plate glass and lean into the clean area. There are no corners or flat surfaces to collect dirt or dust. All steel is grounded to preclude static charges. Even screwheads are covered with stainless buttons to streamline them into flat surfaces. Doors are frameless plate glass with no dust-gathering ledges or moldings. All assembly, testing, and packaging operations are performed under individual stainless-steel "Sterilshields."

The area is, of course, under positive air pressure. The air is changed 20 times each hour and two-stage-filte for a maximum particle size of micron. Temperature is held at (±1)°F and humidity at 30-40%.

Lenses for the lighting fixtures integral with the ceiling and the tures themselves are accessible fr outside the controlled area.

Traffic, one of the greatest ener of a clean environment, has been tually eliminated here. No one ex workers regularly assigned to the may enter. Workers are cleaned special "air-showers" and must do complete nylon uniform covering ev thing but their faces before ente the area. They cannot use cosme chew gum, eat food, smoke, or have lead pencils in the room. special line-free data paper is allo

New Departure engineers main that such ultra-clean facilities are of the most promising approache solving the reliability problems of cise missile/space gyroscopes guidance systems.

Switch to liquid hydrogen . . .

Centaur: New Power, New Problems

by Jay Holmes

SIX OR SEVEN MONTHS from ow, the United States will begin flight ests of the *Centaur*, which will embody ie most radical advance in rocket pro- ulsion since the Germans at Peene- iunde developed the *V-2*.

Centaur, a 2½-stage vehicle based n an *Atlas* ICBM, has an upper stage iat burns liquid hydrogen, a fluid that iust be kept at the fantastically low emperature of –423°F, a scarce 36° ahrenheit above absolute zero. Liquid ydrogen is 126° colder than LOX, the xidizer in *Centaur's* bipropellant ystem.

Switching from RP-1 to liquid hy- rogen increases a liquid rocket's spe- fic impulse from 30% to 40%. Al- iough additional tankage is required ecause of hydrogen's extremely low ensity, there still is a large gain in erformance.

One comparison between conven- onal and high-energy upper stages is rovided in the lift capacity of *Centaur* id *Atlas-Agena B*, which has a large pper stage with storable liquid propel- nts. For a nominal 300-mile orbit, *entaur* will lift 8500 lbs., more than alf again the 5300-lb. capacity of *tlas-Agena B*. For escape, *Centaur* in lift 1450 lbs., compared with 800 s. for *Atlas-Agena B*.

But switching to liquid hydrogen is brought a series of new technical oblems, as well as intensification of me old ones. Its greater performance pacity creates opportunities that, in rn, create other technical problems.

• **New headaches**—*Centaur* will be e first rocket vehicle designed specif- ally for achieving a 24-hour orbit— iich opens a whole series of head- hes in achieving that very precise tra- ctory, 22,900 miles above the equator.

The first 10 *Centaur* flights will be imarily concerned with vehicle de- lopment. They will cover a period om 1961 to late 1963 or early 1964. othing but vehicle performance gear ll be aboard the first three flights. On e remaining seven, other scientific d spacecraft experiments will be car- d on a space-available basis.

Some of the payloads will be ex- riments in Defense programs, such the *Advent* 24-hour communications ellite. NASA experiments include the oject *Surveyor* soft-landing spacecraft d a few planetary shots.

NASA MODEL of the Centaur vehicle.

One of the most interesting experiments under consideration is a NASA attempt to launch multiple active communications satellites. Under the scheme, possibly 8 or 10 satellites would be packed into a container launched into an elliptical orbit with apogee upwards of 2000 miles.

Each time the container reached apogee, one satellite would be ejected, with a small propulsion unit set so that it would go into a high circular orbit. Each would be pointed in a slightly different direction, so that the orbits would be different.

No date is set for the first multiple launching, but it probably would be late in the *Centaur* development program, probably no earlier than 1963. Multiple launching of communications satellites is considered the best approach to reducing the cost enough to make intercontinental satellite communications commercially feasible.

The toughest technical problems in developing *Centaur* are related to the extremely low temperature of liquid hydrogen. Heat transfer is causing numerous headaches. During the coast periods between the three powered phases of flight to a 24-hour orbit, the tanks will be partly filled with liquid hydrogen slowly bubbling into gas.

While in direct sunlight, the *Centaur* tanks will be heating up fairly rapidly. Considerable study is in progress at NASA laboratories and by Convair, the prime contractor, to learn how much heat can be withstood and how much insulation must be used to avoid bursting the pressurized stainless steel tank. One solution under consideration is turning the engine end toward the sun as a shield.

• **Venting problem**—When the pressure builds too high, the tanks will be vented. But venting creates another problem. Under zero-g conditions, a mixture of gaseous and liquid hydrogen becomes a relatively uniform foaming suspension. Thus venting would release liquid along with the gas, considerably reducing total impulse.

The Air Force's Wright Air Development Division is cooperating with NASA on experiments in its KC-135 aircraft specially equipped to provide up to 35 seconds of weightless flight in a ballistic trajectory to investigate hydrogen properties. *Aerobee* sounding rocket shots from Wallops Island are planned soon to provide more data.

NASA and contractors are experimenting with several techniques of equipping vents to distinguish between liquid and gaseous hydrogen. All are classified.

A third problem is making certain that the liquid finds its way into the engine without too much gas mixed in at restart. Ullage rockets with thrust somewhat under 1 g create "gravity" that pushes the mixture back into the engine, but too much gas would make the engine run away and possibly destroy itself.

There is no plan for any fourth start for the *Centaur* engines, developed by Pratt & Whitney. The engines are capable of starting an indefinite number of times, but fuel will be provided only for three: the initial powered phase into a low orbit, the lift into an ellipse leading to a 24-hour orbit, and the final burst that converts the ellipse to a circle about the equator.

If further correction is needed, it will be provided by small, precise propulsion devices attached to the spacecraft itself. ⌘

Energy Technology
At
THOMPSON
RAMO WOOLDRIDGE
INC.

In the development of advanced energy technology, efforts at Thompson Ramo Wooldridge encompass energy conversion, regulation, inversion and control. Research and development is currently in progress on:

Solar Turboelectric Space Power
Nuclear Turboelectric Space Power
Cryogenic Turboelectric Power
Underwater Propulsion
Regenerative Fuel Cell Power
Thermionic Power
Magnetohydrodynamic Power
Electric Propulsion
Integrated Environmental Control Systems
Vehicle Atmospheric Control
Closed Cycle Oxygen Regeneration

Selected assignments are available now in analytical and experimental heat transfer, fluid dynamics; liquid metal and gas bearing research, turbomachinery analysis, plasma physics and electrochemistry.

Scientists and engineers with unusual capabilities are invited to investigate positions at Thompson Ramo Wooldridge Inc. For additional information, write informally or forward your resumé in confidence to Mr. James Panoska.

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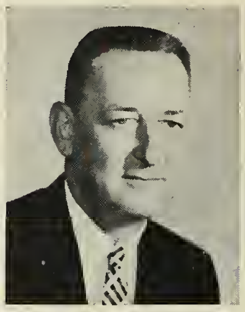
Cleveland 4, Ohio**

names in the news


LANG

BUTTERFIELD

DUDENEY

John P. Butterfield: Named executive engineer on the corporate staff of The Martin Co. Was formerly director of advanced projects for the Chrysler Corp. From 1952 to 1958, as executive engineer for Chrysler he worked directly for **Dr. Wernher von Braun** on the *Redstone* and *Jupiter* missile programs.

Herman I. Rudman: Former manager of sales promotion with Photocircuits Corp., named marketing manager of Melpar, Inc.'s Special Products Dept.

Gordon D. Wedell, E. F. Forsythe and **Edwin A. Boyan:** Join the technical staff of the Data Systems Project office of Ramo-Wooldridge, a division of Thompson Ramo Wooldridge Inc.

Charles F. Thomas: Former leading engineering and contracting executive of the Lockheed Aircraft Corp., joins RCA's Major Defense Systems in the newly-created post of manager of marketing and planning.

Peter N. Dudeney: Appointed director of engineering for Vitro Electronics, a division of Vitro Corporation of America. Prior to joining the firm in 1958 as senior electronic design engineer, he served as senior design engineer for Bendix Friez and senior electronic engineer for A. V. Roe, Ltd.

Dr. E. R. Roberts and **J. B. Cowen:** Appointed to newly created positions of assistant manager with Aerojet-General Corp.'s Solid Rocket Plant. **Dr. Karl Klager** is now senior division manager, Solid Rocket Development, and **Dr. A. O. Dekker,** senior division manager, Solid Rocket Research.

Dr. Alan J. Rowe: Named manager of research in Hughes Aircraft Co.'s industrial dynamics department. Was formerly director of management control systems research at the System Development Corp.

Jack Lang: Former sales manager for Kimball Manufacturing Corp., named director of marketing for McCormick Selph Associates, responsible for all marketing and sales activities as well as advertising and public relations.

H. Malcolm Wilkinson: Appoint manager of the Data Acquisition a Logging Section of Stromberg-Carlso Electronics Div. Was formerly with t Research and Advanced Developme Div. of Avco Corp. and most recently charge of Instrumentation Systems Epsco, Inc.

Abel M. Scbwartz: Named director advertising for Astrosystems, Inc. W associated with Thiokol Chemical Corp Reaction Motors Div.

Alan M. Brown and **Bernard Kliban** Join Electro-Mechanical Corp. as pre dent and vice president-engineering, spectively. Both were formerly associat with Adler Electronics.

Dr. Edward A. Parker and **James Powers:** Promoted to technical direct and research director, respectively, Technic, Inc.

Melvin Kohner: Appointed chief gineer of John Oster Manufacturing C Avionics Division.

Dr. Robert W. Mason: Former te nical supervisor of laboratory resear named assistant director of laboratory search at Allied Chemical's Gene Chemical Division.

John D. Blitch: Appointed assist to the executive vice president of C vair Division of General Dynamics Co Was formerly on the staff of the p gram planning manager for the *Pola* missile system at Lockheed Missiles a Space Div.

Strain "Tim" Sutton: Named natio sales manager of Tensor Electric Devel ment Co., Inc.'s newly created commer division. Was formerly sales manager Acoustica Associates and Narda Ult sonics.

Dr. C. M. Wolfe: Joins Borg-War Controls as head of Transducer Engine ing. Previous posts: research specialist United Electrodynamics; group des engineer at Convair; supervisor in plied physics at North American A tion, and supervisor, Physical Measu ments Dept., at Aerojet-General.

—contracts—

NASA

vco Corp.'s Research & Advanced Development Div., Wilmington, Mass., for study of the re-entry portion of *Project Apollo*. Subcontract from Convair.

iannini Controls Corp., Duarte, Calif., for continued research on an accelerator which eventually may be capable of reproducing orbital re-entry conditions in the laboratory. Amount not disclosed.

49,252—Electro-Optical Systems, Inc., Pasadena, for test and evaluation of a company-developed hydrogen-oxygen fuel cell.

NAVY

ubic Corp., San Diego, for building 1100 seven-bit binary counters for the U.S. Navy Electronics Laboratory. Amount not disclosed.

26,000,000—The Bendix Corp., for continued development and evaluation of the *Eagle* missile system.

43,386—Walker Electrical Co., Inc., Atlanta, for missile fire control switchboard for *Tartar*.

AIR FORCE

lin Mathieson Chemical Corp., New York City, for development of gas generators for both stages of the *Skybolt* missile. Amount not disclosed.

eneral Motors' Allison Div., for building second-stage rocket motor cases for the *Minuteman*. Subcontract from Aerojet-General Corp. Amount not disclosed.

8,232,000—Avco Corp.'s Electronics & Ordnance Div., Cincinnati, for continued production of the FPS-26 height finder radar.

2,485,000—General Electric Co., for procurement and production of on-site and off-site depot level maintenance supply and support services for AF-owned ground communications electronics equipment.

1,000,000—Aerojet-General's Spacecraft Div., Azusa, Calif., for conducting study and research on a swept-wing aerospace craft.

950,000—Technical Operations, Inc., Burlington, Mass., for continued development of a two-sided global air war game.

740,855—Beckman Instruments Inc.'s Systems Div., Anaheim, Calif., for building 17 electronic units for the *Minuteman*.

199,769—General Electric Co.'s Technical Military Planning Operation, Santa Barbara, for study and research on a class of advanced systems to help keep U.S. defense in step with technological progress.

39,248—Douglas Aircraft Co., Santa Monica, for studying the delivery of food and other essentials to men in earth satellites. Project *SLOMAR*.

ARMY

77,800—Ransdell Construction Co., Dallas, for shops, missile assembly and maintenance and technical supply building.

76,000—Colorado Research Corp., Broomfield, Colo., for a new type of television transmission system applicable to military communications, reconnaissance and surveillance in space technology.

15,715—Western Electric Co., New York City, for *Nike* repair parts. (Four contracts.)

39,000—Joseph Della Penna Construction Co., Haskell, N.J., for improved *Nike-Hercules* system.

80,000—Hallock Construction, Inc., Easton, Md., for improved *Nike-Hercules* systems.

94,693—B. B. McCormick & Sons, Inc., Jacksonville Beach, Fla., for construction of a mobile launch facility for the *Minuteman*.

8,545—Radiation, Inc., Melbourne, Fla., for digital tabulation and plotting system.

9,778—Hawkins & Westbrook, Abilene, Tex., for re-entry vehicle facilities at Dyess AFB.

7,049—The Martin Co., Orlando, for emergency replenishment spare parts for *Lacrosse* missile system.

As tall as a 7-story building... but it uses tiny BRISTOL CHOPPER

More than 40,000 parts, each of which must meet the most stringent reliability standards, make up the U. S. *Atlas* intercontinental ballistic missile, built by prime contractor Convair (Astronautics) Division, General Dynamics Corporation.

Among these parts is the Bristol Syncroverter* chopper . . . adding to its record of service in U. S. guided missile systems of almost every type since their very beginnings.

Billions of operations. To insure the reliability so necessary in aircraft and missile operations, Bristol Syncroverter choppers are constantly under test at Bristol, with and without contact load. One example: We've had five 400-cycle choppers operating with 12v, 1ma. resistive contact load, for more than 26,000 hours (2.96 years) *continuously* without failure—over 37-billion operations!

Many variations of Bristol Syncroverter choppers and high-speed relays are available—including external-coil, low-noise choppers. Write for full data. The Bristol Company, Aircraft Equipment Division, 173 Bristol Road, Waterbury 20, Conn.

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*T.M. Reg. U. S. Pat. Off.

actual size

BRISTOL FINE PRECISION INSTRUMENTS FOR OVER SEVENTY YEARS

Circle No. 16 on Subscriber Service Card.

Navigation Satellite Receiver

Type 2501-A Receiver, available from Nems-Clarke Co., (Vitro Electronics) has been designed specifically for measuring the Doppler shifts of incoming signals over a wide tuning range.

The unit is continuously tunable from 55 to 260mc and features a low noise figure throughout the band. Two inputs are provided: one for the frequency to be measured, and a second input for a standard reference signal. In normal operation the reference input amplitude is adjusted to operate the detector in a linear fashion, and its frequency is offset by an amount slightly greater than the maximum Doppler shift expected. This produces detector action similar to a frequency mixer, the output being the difference frequency between the incoming signals. Operation in this manner produces an output signal in which the s/n has not been deteriorated due to detector action.

Circle No. 225 on Subscriber Service Card.

Linear-Flow Transducer

H. E. Sostman & Co. has available a line of linear-with-flow transducers suitable for use with orifice plates, flow tubes, or weirs. Series #IP-1170 Flow Transducers utilize an opposed-bellows meter body in conjunction with a precision potentiometer winding to provide an output signal directly proportional to flow. The extraction or characterization is accomplished by tapping and shunting the winding to the specific curve desired. Total resistance values from 500 ohms up to 5000 ohms are available depending on specific application requirements.

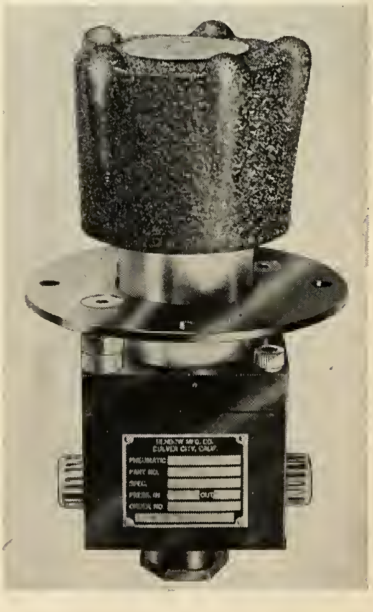
Circle No. 226 on Subscriber Service Card.

Pneumatic Regulator

A lightweight pneumatic regulator, Series 8225, that operated from 0 to 5000 PSI with constant outlet pressure, has been developed by Benhow Manufacturing Corp.

Pressure outlet is adjustable from 0 to maximum with one LO-Torque hand control, or an electric remote control unit, as required. An automatic relief provides system protection and a special ball-bearing guide insures accurate sensing. Temperature range is from –65° to +275°F; inlet pressure to 6500 psi; proof pressure 8000 psi.

Circle No. 227 on Subscriber Service Card.



Magnetic Tape Head

The Nortronics Co., Inc., has ava
able a "J" Series of miniature recor
erase/playback magnetic tape hea
These heads measure ¼ in. diame
by ¼ in. long, and are designed f
use in transistor circuitry. The hea
have a low impedance and excelle
frequency response. Track width
0.070 in.

Circle No. 228 on Subscriber Service Card.

Synchro Dial and Weight

Angler Industries has available
line of synchro dials and weights f
friction torque tests, synchronizing te
and spinning tests per MIL-S-20708.

The Dial in this testing device
supplied with a Collet type clamp f
quick disconnect for high producti
testing and the complete unit may al
be used for environmental testing
Synchros. A basically essential testi
device, the F-100 series as it is call
is suitable for testing Synchros from si
11 to size 37.

Circle No. 229 on Subscriber Service Card.

High Accuracy Flowmeter

A flow measurement system f
liquids having an accuracy of ¼
1% of instantaneous reading is bei
produced by Auto-Control Labor
tories, Inc. The "High Accuracy Flo
meter" is a positive-displacement m
tiple-piston unit converting precise
measured volumes of liquid into a hig
frequency pulse rate proportional to t
volume measured. This signal can
fed into a digital counter reading
rectly in GPM or to an analog met
or X-Y plotter.

Circle No. 230 on Subscriber Service Card.

Surface Thermometer

Arthur C. Ruge Associates, In
has added a series of transducers pe
mitting surface temperature measur
ments over a usable range from a
solute zero to 2000°F.

The units consist of a grid of C
platinum wire encapsulated in pu
aluminum oxide. The first two tran
ducers in this series are the APM-5
a 50-ohm nominal resistance unit, a
the APM-100, with 100 ohms nomin
resistance.

Circle No. 231 on Subscriber Service Card.

Woven Wire Filter Types

Over 225 items, of 20 basic type
of standard woven wire mesh, elemen
in-line filters are now available fro

ircraft Porous Media, Inc. These fil-
r assemblies have inlet and outlet con-
ections on the axis of the sinter-
onded woven wire elements. Standard
nits range in tube or pipe sizes from
to 12 in.

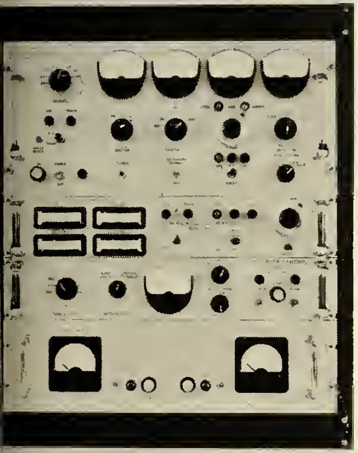
Removal ratings vary from 1½
icrons to 149 microns or coarser. A
riety of fluids, ranging from cold
ses to hot viscous polymers, may be
andled over the temperature range
320°F to 1000°F. Fuels, lubricating
nd hydraulic fluids are among the hun-
eds of fluids which can be accom-
odated.

Circle No. 232 on Subscriber Service Card.

hase Lock Receiver

A series of Phase Lock Receivers is
ailable from Hallamore Electronics
ivision, Siegler Corp.

The receiver, designed to integrate
allamore phase-lock detection with an
ntire series of complementary modules,



erates with a wide dynamic range of
0 db at a sensitivity of −185 dbw.
he five modules that constitute the
ceiver are the detector, converter,
nverter control, remote acquisition
ntrol, and power supply.

Circle No. 233 on Subscriber Service Card.

uality Control Cabinet

A Space Saver testing unit is being
anufactured by Alpha Electric Re-
geration.

The unit is Composed of a roll-
out-type chassis cart and three sepa-
te, self-contained cabinets: high-low
nperature, humidity, and high heat
nperature. Cabinets are available with
her mechanical refrigeration or liquid
O_2. Removable for use on or off
e cart, the cabinets allow three in-
vidual testing procedures to be con-
cted at the same time.

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new literature

SUPERBOLT REVIEW—A family of superbolts and companion locknuts for applications up to 900°F is covered in two new bulletins published by Standard Pressed Steel Co. Separate four-page bulletins review the new 900-degree aircraft bolt, the EWB 926, and mating featherweight self-locking nut—the FN 926. Between them, the two fasteners comprise the first threaded joint of 200,000 psi ultimate tensile strength at 900°. Room temperature tensile rating is 260,000 psi minimum.

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VACUUM COATINGS—Custom vacuum coating services for functional and unusual decorative purposes are the subject of a 4-page brochure just issued by Poly-Kote, Inc. Described are coatings for abrasion, corrosion, and high temperature resistance, as well as unusual electronic effects.

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RESISTANCE WELDING CALCULATIONS—An 8-page brochure (SP-8A), containing tables which simplify calculation of the electrical power supply required by resistance welders, is available from the Taylor Winfield Corp. Factors of electrical demand and duty cycle are tabulated to establish minimum welder transformer KVA ratings. Maximum safe rate of operation of a welder can be readily determined by use of these tables, which establish the maximum electrical duty cycle of a transformer under various demand loads.

Circle No. 202 on Subscriber Service Card.

GAGING INSTRUMENTATION—A product brochure on gaging instrumentation, is available from Measurement Control Devices. Designated Catalog No. G-100, the illustrated brochure describes in detail the systems and components available for the continuous indicating the monitoring of minute changes in dimensions for control usages. Describing bearing, comparator and height type gaging heads, the brochure also explains in detail mounting stands as well as amplifier and display units for use in closed loop servo indicating systems or such as extended scales indicator and strip chart recorders are also described.

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MISSILE HYDRAULICS COMPONENTS—An eight-page brochure on missile hydraulic components and their application has been published by Denison Engineering Division, American Brake Shoe Co. The publication outlines the use of hydraulic pumps, motors, and controls in missile transporters, erectors, launchers and in testing and checkout systems. Illustrated sections on completely integral hydraulic power plants and valves are included with performance data.

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NASA's Ion Engines

To the Editor:

It was encouraging to see an article on electric propulsion in your magazine (M/R, Nov. 7, pp. 24-25). We, at the National Aeronautics and Space Administration, appreciate your interest in this rapidly developing propulsion field.

While the NASA program for flight testing ion engines is still under discussion, the present program calls for initial flight tests of smaller ion engines than the 0.1 lb. thrust, 30 KW engine mentioned in your article. The smaller engines can be tested for approximately an hour above 250 n.m. using battery power in payloads weighing around 150-200 lbs. rather than the 100 lb. payload M/R indicated. The NASA-developed *Scout* vehicle is being considered for these initial ballistic flight tests of ion engines.

Also, I want to clarify some of the statements which were attributed to me in the article. On the question of flight tests, I was quoted as saying that it was impossible to prove a higher (specific) impulse figure (20,000 sec. or more) without experiments in space. The problem is more basic than you indicated. We cannot prove any impulse figure or cannot be certain that an ion engine will operate at all in space without flight testing. The question of whether the positive ion beam can be effectively neutralized by injection of electrons can only be answered with certainty by experiments in space. As you pointed out, earth-bound test tanks do not adequately simulate the condition of outer space due to the imperfect vacuum and finite walls. Thus, we are studying various methods to test ion beam neutralization schemes and to check the operation of various ion engines in space.

If the initial tests for neutralization prove satisfactory, we will test larger engines and hope to have an operating engine by 1965 which will mate with the 30 KW SNAP-8 power supply. It is hoped that this engine will produce 0.1 lb. thrust at a specific impulse of 4000-6000 seconds. This particular program is to develop a first generation ion engine and higher impulse engines can be expected later.

The M/R article mentioned that the electric engines will reduce the cost, weight and complexity of launch vehicles required for missions to Mars, Venus and beyond. The electric engines are being designed to operate in space after they have been placed there by a launch vehicle of the *Centaur* and *Saturn* class. Thus, the development of these engines will only affect the design of the upper stages of the vehicle and not the basic launch vehicle.

My final comment concerns the subject of NASA-sponsored supporting r search on electric propulsion engine which included ion, arc jet, MHD, ar colloid. You are correct in saying th NASA Headquarters will be receptive t unsolicited proposals. However, these pr posals also can be submitted directly t Marshall Space Flight Center, Huntsvill Ala., where Dr. Ernst Stuhlinger and h staff sponsor and direct research and d velopment programs in electric propulsio

Again, thank you for publishing a article on the new and challenging fie of electric propulsion. We appreciate yo interest in the NASA programs.

Richard J. Hayes
Capt., USAF
Technical Specialist
Electric Propulsion
National Aeronautics
Space Administration
Washington, D.C.

No Trouble on Samos Pad

To the Editor:

The Oct. 17 M/R tells (on p. 16) the first *Samos* shot by the Air For from the Naval Missile Base at Poi Arguello, Calif., which I was lucky observe.

It was a perfect launching even *Agena B* did not perform as intended.

This launch site was turned over to t Air Force on March 18, 1960, just s months and 23 days before firing.

Wells Benz Inc., were the Gener Contractors on the only two *Samos* pa constructed at Point Arguello to date.

Incidentally, the gantry shown in t picture is not from Point Arguello; t gantry at Arguello has an all-electr bridge crane and there is no metal sidi on the outside. Somebody goofed.

Here is hoping that the next *Agen* works and gives Nikki a lot of worry sending us pictures of his front door.

R. M. (Red) Cameron
General Superintendent
Wells Benz Inc., Contracto
Phoenix, Ariz.

High Praise for Kane

To the Editor:

The article by Lt. Col. Francis Kane in M/R of Oct. 24 ("A Call for I tellectual Innovations") represents son of the finest thinking that has ever be displayed in any magazine in the astr nautics industry. Though his article m not represent the official thinking of t Air Force, it would be well for all A Force officials to read and understa Colonel Kane's article without delay, a to indeed make this the official line thought. Colonel Kane has in the sho space of a little over two pages point out the crucial ailment in the defense e tablishment in the United States. The ne for basic research is literally the mo crucial need in our time.

Saunders B. Kramer
Senior Member, American Astr nautical Society
Fellow, British Interplanetary Society
Sunnyvale, Calif.

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—when and where—

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onference on Electro-Optical and Radiation Devices sponsored by IRE Professional Group on Electron Devices and AIEE, Stanford Research Institute, Menlo Park, Calif., Nov. 20-21.

merican Physical Society, University of Chicago, Chicago, Nov. 25-26.

SME Winter Annual Meeting, Statler-Hilton Hotel, New York City, Nov. 27-Dec. 2.

overnment Contracting Course, National Defense Education Institute, sponsored by National Security Industrial Association and Harbridge House, Inc., Los Angeles, Nov. 28-Dec. 9.

r Research and Development Command's Seventh Annual Science and Engineering Symposium, Statler Hilton Hotel, Boston, Mass., Nov. 29-30.

DECEMBER

E Professional Group on Vehicular Communications, Sheraton Hotel, Philadelphia, Dec. 1-2.

nerican Institute of Chemical Engineers, Statler Hotel, Washington, D.C., Dec. 4-7.

ectronics Industries Association, Third Conference on Maintainability of Electronic Equipment, Hilton Hotel, San Antonio, Tex., Dec. 5-7.

RS Annual Meeting and Astronautical Exposition, Shoreham Hotel, Washington, D.C., Dec. 5-8.

tional Conference on the Application of Electrical Insulation, Conrad Hilton Hotel, Chicago, Dec. 5-8.

nerican Nuclear Society, Mark Hopkins Hotel, San Francisco, Dec. 11-14.

ternational Scientific Radio Union (URSI), IRE Fall Meeting, NBS Boulder Labs, Boulder, Colo., Dec. 12-14.

dustrial Building Exposition and Congress, Coliseum, New York City, Dec. 12-15.

nual Eastern Joint Computer Conference, Hotel New Yorker and Manhattan Center, New York City, Dec. 13-15.

omic Industrial Forum, Annual Conference, Fairmont Hotel, San Francisco, Dec. 14-16.

titute of the Aeronautical Sciences, Wright Brothers Lecture, Smithsonian Institution, Washington, D.C., Dec. 17.

nerican Association for the Advancement of Science, Annual Meeting, Philadelphia, Dec. 26-31.

JANUARY

nposium on Thermoelectric Energy Conversion, Joint Technical Society, Department of Defense, Statler Hilton Hotel, Dallas, Tex., Jan. 8-12.

enth National Symposium on Reliability and Quality Control, Bellevue-Stratford Hotel, Philadelphia, Jan. 9-11.

ernational Congress and Exposition, Society of Automotive Engineers, Cobo Hall, Detroit, Jan. 9-13.

American Astronautical Society, Annual Meeting, Sheraton-Dallas Hotel, Dallas, Tex., Jan. 16-18.

Winter Instrument-Automation Conference and Exhibit, Instrument Society of America, Jefferson Hotel and Kiel Auditorium, St. Louis, Jan. 17-19.

29th Annual Meeting, Institute of the Aeronautical Sciences, Hotel Astor, New York City, **(Honors Night Dinner,** Jan. 24), Jan. 23-25.

American Mathematical Society, National Meeting, Willard Hotel, Washington, D.C., Jan. 24-27.

Society of Plastics Engineers, Annual Technical Meeting, Shoreham and Sheraton Park Hotels, Washington, D.C., Jan. 24-27.

American Institute of Electrical Engineers, Winter General Meeting, New York City, Jan. 29-Feb. 3.

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editorial . . .

Foreign Policy and Your Own Life

THE DANGER AREAS of American foreign policy—those areas which contain a threat to the security of the country—are being studied and charted by a special committee named by President-elect John F. Kennedy shortly after his nomination.

Chairman of the committee is Paul H. Nitze, president of the Foreign Service Educational Foundation, a member of the U.S. Strategic Bombing Survey and former Department of State economist. Members are: David K. E. Bruce, former ambassador to France and Undersecretary of State; Roswell L. Gilpatric, former Undersecretary of Air Force; James A. Perkins, consultant to the RAND Corp. and the Dept. of Defense and a member of the Counsel of Foreign Relations.

The Nitze group, known generally as the Kennedy Committee on Defense and Foreign Policy, is one of two named by the President-elect. The other, under the chairmanship of Sen. Stuart Symington, is mapping out a proposed reorganization of the Department of Defense (M/R, Nov. 14, p. 8). Both groups have been asked to report by Dec. 31.

Mr. Nitze's assignment is formidable. Consider the scope of it: the international problems of today which have a direct bearing on the security of the United States.

Do we aid and abet De Gaulle's plan to make France a fourth nuclear power, or do we stand aloof? How long can we hold on to the strategic air bases in North Africa? What would be the effect of turning nuclear weapons over to NATO? How do we deal with the old problems of Quemoy and Matsu, which unexpectedly became a campaign issue?

The state of our foreign trade balance directly affects our security, as does our overall prestige abroad. There are Cuba and Castro, the possibly inspired revolts of Central America, the recognition of Red China and the defense of Berlin. The proposed reorganization of the Pentagon has a bearing, to the extent that it affects our military posture.

The Nitze committee in some form will, we understand, be a continuing operation. Its reports and studies will be available to the White House and the Departments of State and Defense.

IF THE ASSIGNMENT given the committee is formidable, it is also greatly necessary. It will mean that the major foreign policy problems facing the new President will be studied and analyzed in fine detail.

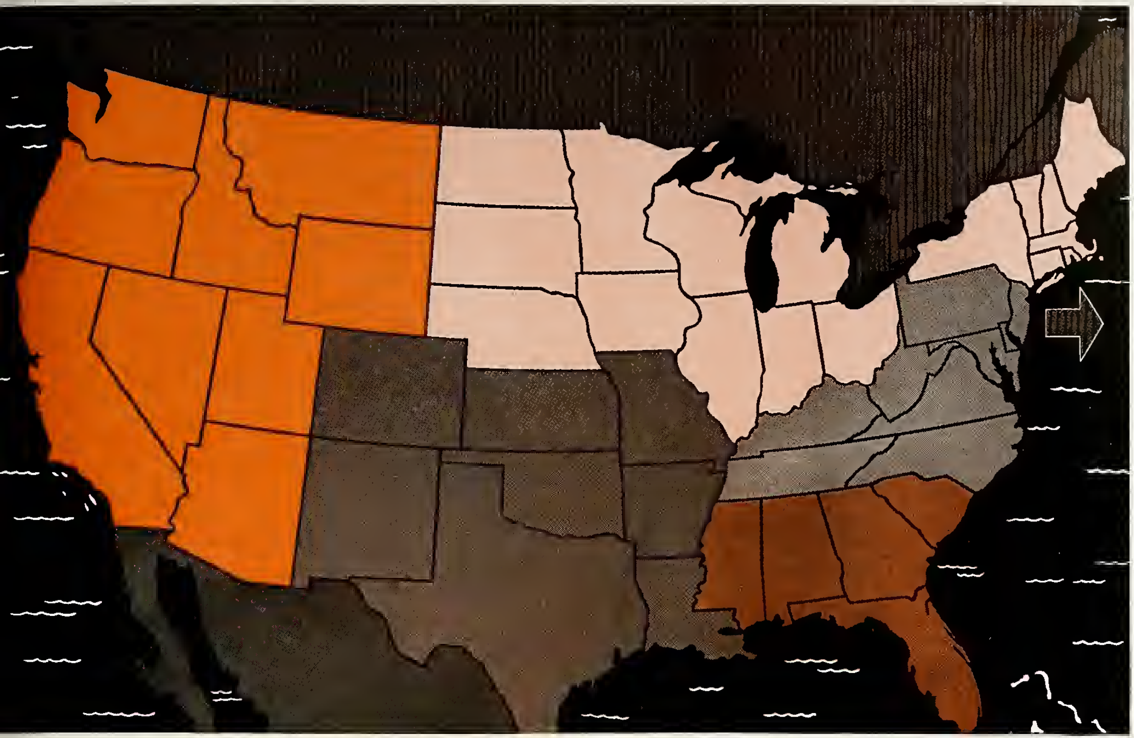
And from the analyses will, we trust and hope, come plans for as many eventualities as can be logically foreseen. They will be the basis of plans, long-range and short, which will give our foreign policy a consistency it has not had in years.

Such plans are not mysterious and remote. They affect the everyday lives of the American people; particularly they affect the defense industry. Upon some of these plans should be based our capability to fight small wars. Upon others may rest a decision as to how many missiles are needed and what kind; whether or not we resume atomic testing—or spend twice as much in our space exploration program.

Government agencies always plan to one degree or another. Presumably there was a plan for handling the situation should a U-2 be shot down over Russia. If so, it was obviously inadequate.

Good national planning is necessary now as it never has been before. And the more experience, thought and consideration which can be brought into that field the better the planning will be.

Clarke Newlon



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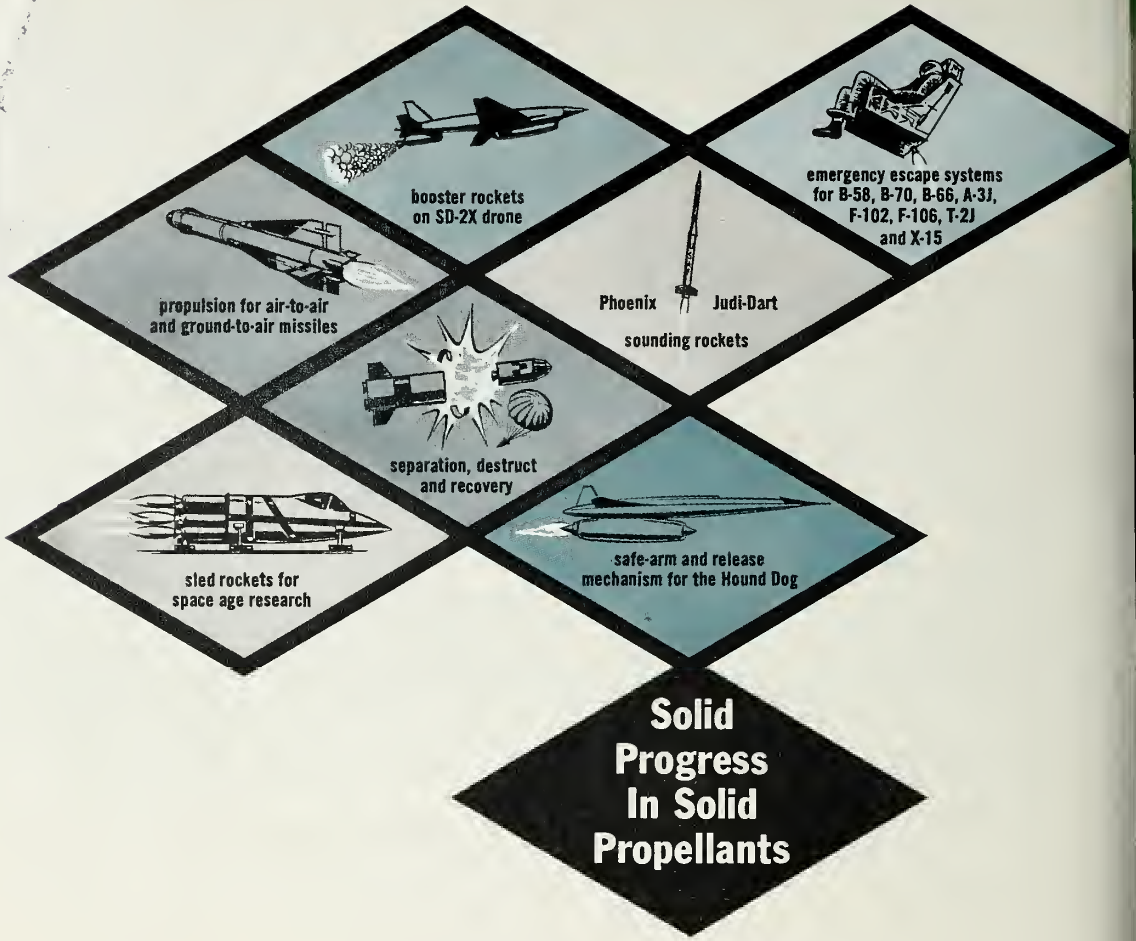
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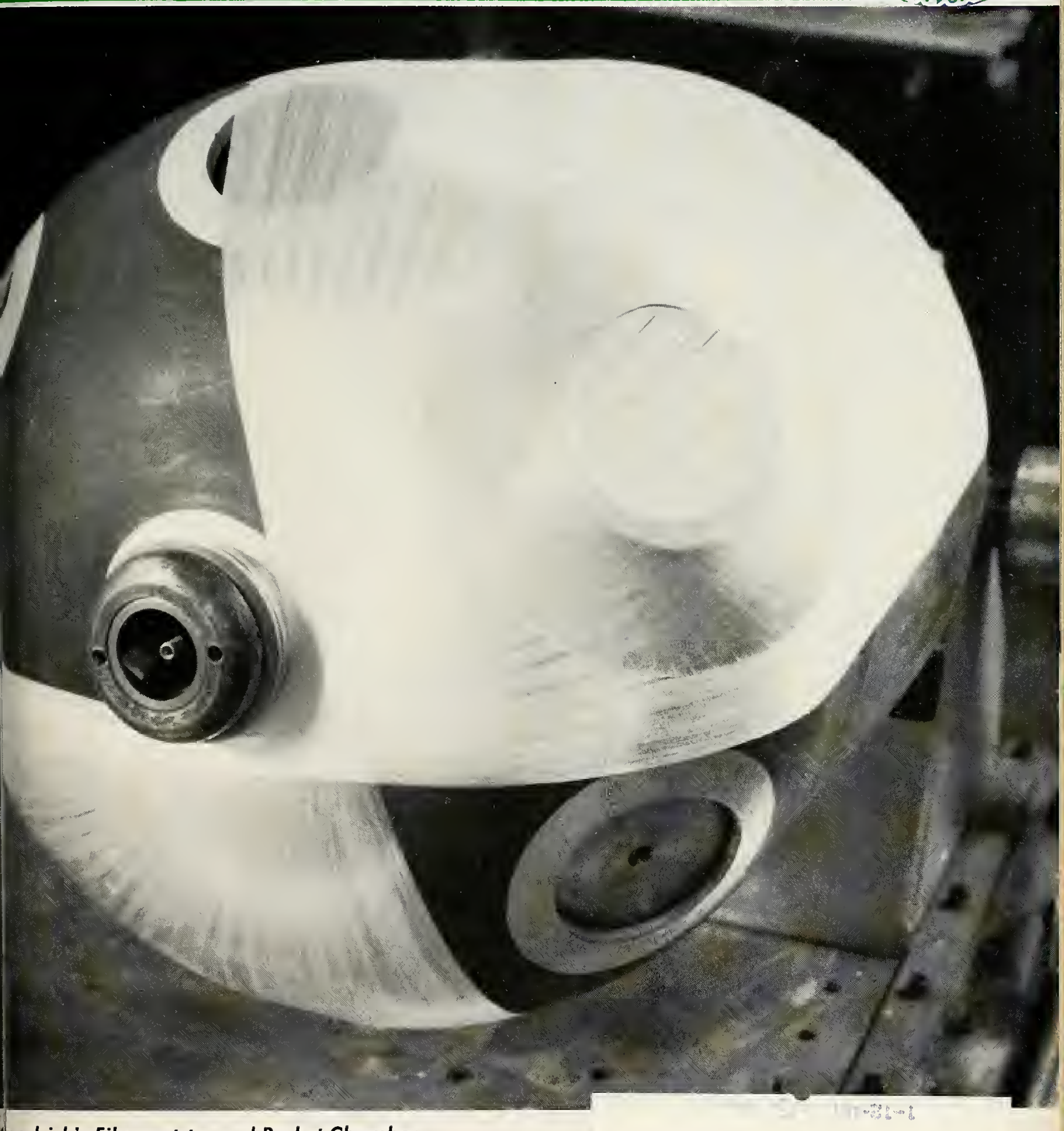

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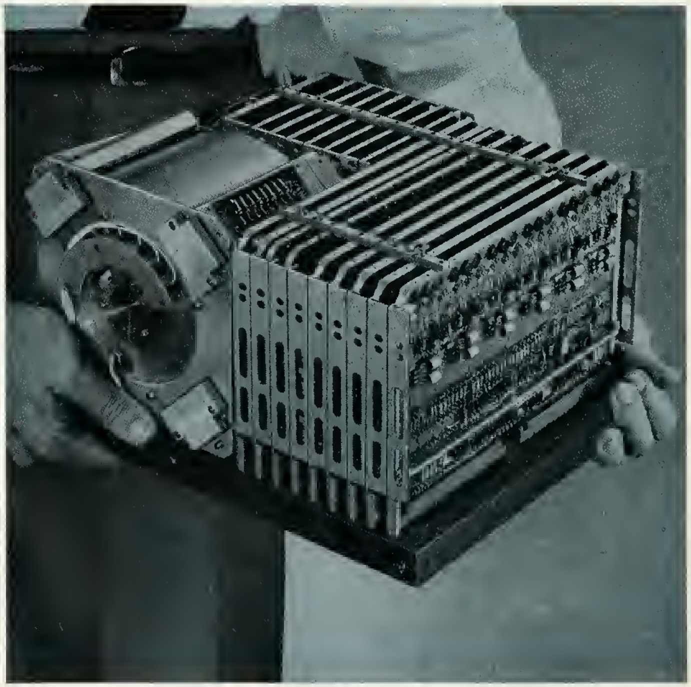

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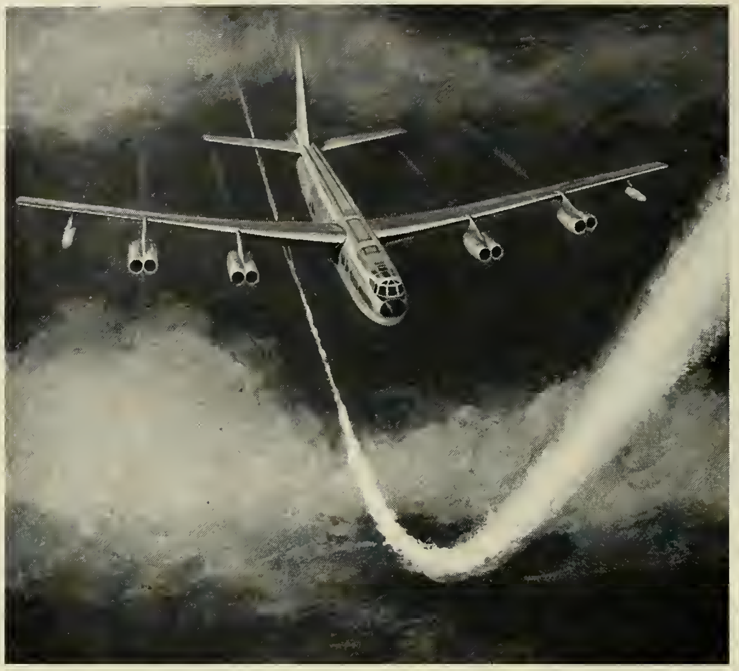

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missiles and rockets

Volume 7, No. 22 November 28, 1960

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THE COVER

Weird effect is created by filament-winding of rocket chamber at B. F. Goodrich. Photo shows port reinforcements and application of longitudinal windings. See story, p. 28.

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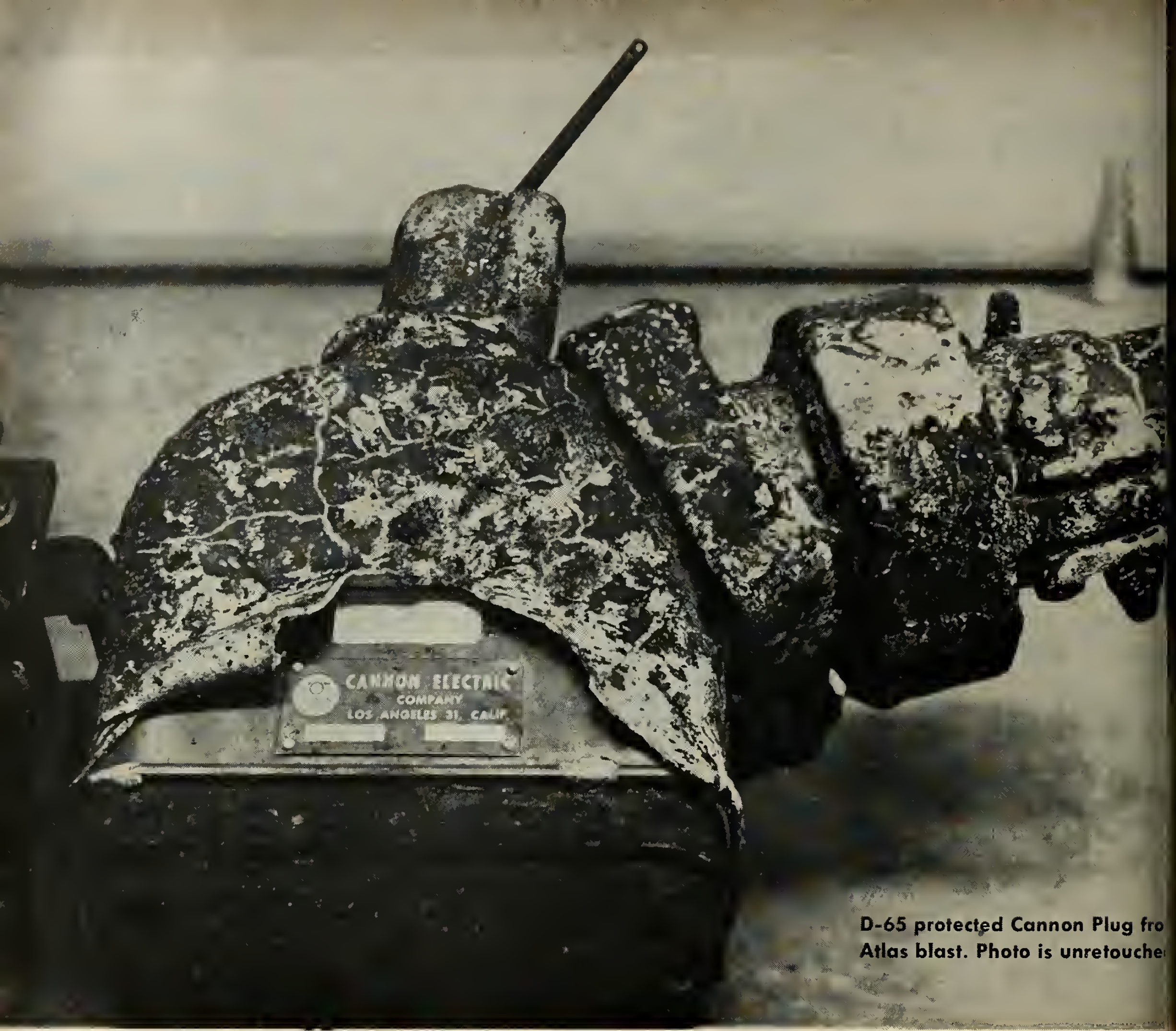

D-65 protected Cannon Plug fro
Atlas blast. Photo is unretouche

NEW FLEXIBLE D-65

flame resistant flexible coating protects ground support and missile equipment from rocket blas

Proved in Atlas test firings: protection at up to 5400° F. for 62 seconds—ease of application at the scene by ordinary paint brush, spray or dip methods—ease of removal and recoating—flexibility after curing. These are some of the advantages of new Dyna-Therm D-65 insulation that promise reduced ground equipment refurbishment time and faster missile refire. Case in point: this standard GMAB electrical connector manufactured by Cannon Electric Company. Coated with D-65 and exposed to Atlas blast, it was found undamaged when coating was cut away as shown. Similar test of coated umbilical cord at 5400° F. for 62 seconds found cord undamaged, D-65 coating still flexible.

D-65 has been successful in insulating neoprene cables, metal and plastic instrumentation housing, piping and general structure, in flight application and ground support equipment.

Dyna-Therm D-65 was developed by Dyna-Therr Chemical Corporation and is marketed exclusively i the U.S. and Canada by Swedlow Inc. Prime contracto for the Atlas is Convair-Astronautics, a Division o General Dynamics Corporation.

Write for data, Dept. 21.

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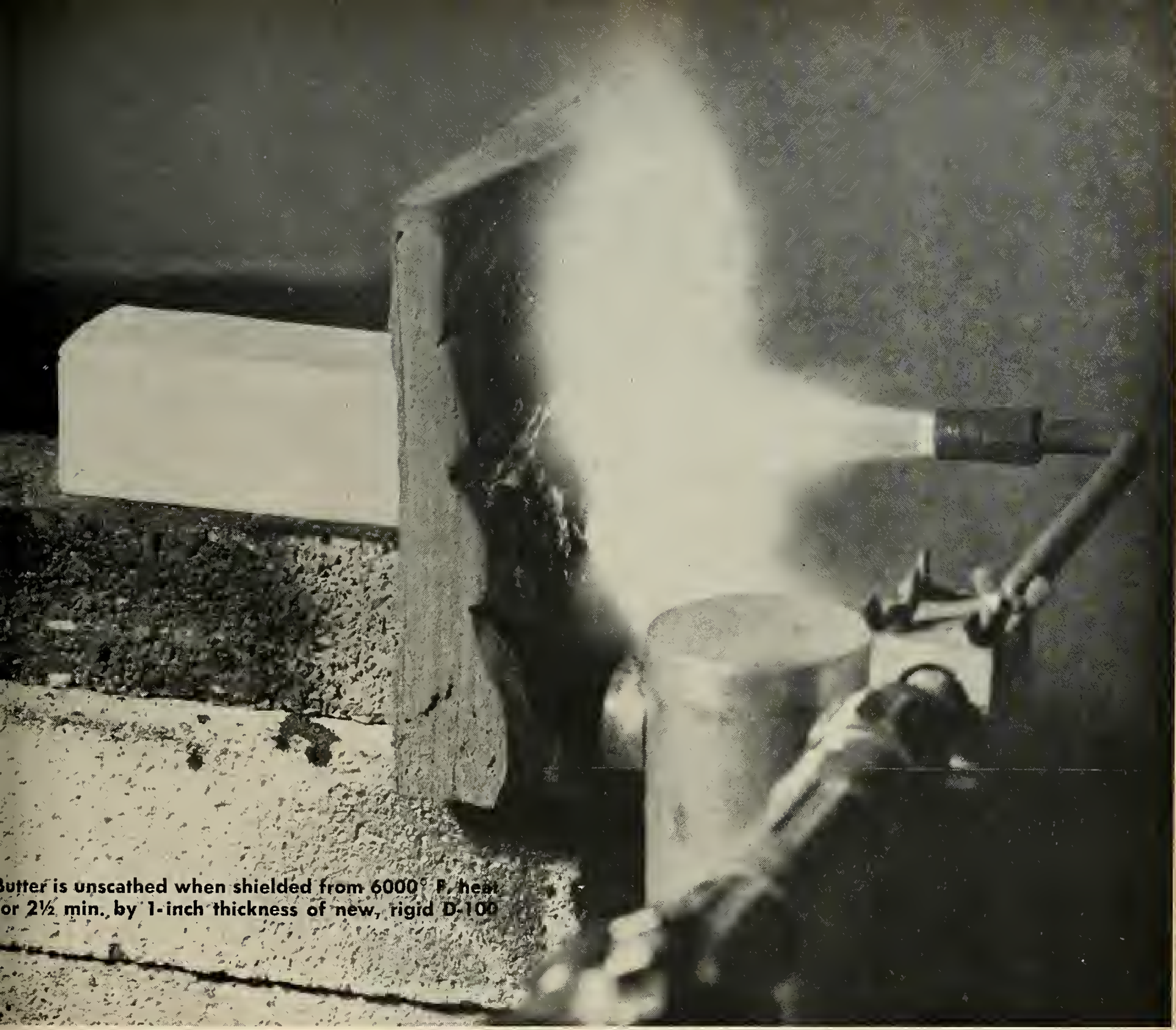

utter is unscathed when shielded from 6000° F. heat
or 2½ min. by 1-inch thickness of new, rigid D-100

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Patent applied for

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letters

Worth Waiting For

To the Editor:

You will be gratified to know that least half of your readership has gleeful called to my attention, in case I mig have missed it, your bouquet (in Technic Countdown) in M/R, Oct. 24, p. 1 under the heading "Not Too Little, Ju Too Late." I cannot help but be disa pointed that, having decided to mentic the *Proceedings of the 1959 Comput Applications Symposium* at all, you cou not have found some more constructi comment to make about them. Inciden ally, our performance wasn't quite as ba as you state; the *Proceedings* were maile out to attendees of the Symposium and a vance purchasers in July, when they cam off the press.

If I had not been personally involve in the preparation of the *Proceeding* and were not familiar with the circun stances in which they were produced, would have to admit that yours was shot that hit the mark. However, withou burdening you with a lengthy series c excuses, I have to point out that the edi ing was essentially a one-man job, carrie out on a shoestring budget by an indivic ual whose responsibilities in the operatio of a contract research establishment ha to take precedence over everything els In view of this, I hoped that the qualit of the result would be the predominar point of interest, rather than the delay i publication. Since in our initial mailin we sent you only a summary and ab stracts, I enclose a copy of the complet *Proceedings* so that you may judge fc yourself.

All in all, it is more in sorrow than i anger that I wish you had grounded thi particular missile.

Andrew Ungar, Asst. Superviso
Computer Applications and Op
erations Research
Armour Research Foundation o
Illinois Institute of Technolog
Chicago

Our "missile" was as Mr. Ungar note aimed solely at the delay in publishing th document. We did have a complete cop of the Proceedings for review, and it i only because of its noteworthiness that w commented for the information of ou readers. We consider that Mr. Ungar di an excellent job; no doubt the dela would have been avoided if he had bee given more assistance.—Ed.

Missile Train Concept

To the Editor:

Please refer to your article on pag 17, M/R, Oct. 17, entitled "'Father' c the *Minuteman*-on-Rails."

With due credit to Mr. Blades an AMF, the idea of mobile missile train originated long before they became in terested. I am enclosing a copy of memo dated May 1, 1958, entitled "Pro posal for Casey Jones Concept Missil Weapons System," which was submitte o the Electro-Motive Division of Genral Motors management for ideas origiating on April 25, 1958. This idea was resented to the Missile Committee of eneral Motors on May 20, 1958.

It was not until June, 1959, 13 months ter, that M/R published its first article n this concept. It might be pointed out hat the only organizations mentioned this article were AAR and ACF.

My principal reason for bringing this p is to point out some of the features f this program which I believe are being verlooked. As outlined, these are:

1) Defensive capabilities of mobile ains equipped with radar and anti-airraft missiles
2) Piggy-back design for transfer to uck or aircraft
3) Foreign application program
4) Ability to concentrate offensive or efensive positions in a new area within ours
5) Design so that missile obsolescence oes not obsolete the entire train.

Ollen Kay
San Diego, Calif.

either Rain nor Snow . . .

o the Editor:

Please find attached my renewal of ISSILE AND ROCKETS at the special airail rate for Argentina.

I would like to take this opportunity say that of all the magazines I subcribed to while in Argentina M/R is the nly one I received regularly and on time.

George H. Muller
Ford Motor Argentina S.A.
Buenos Aires

Correction

In an article titled "Rigid Drift ests Give Useful Gyro Data" in /R Nov. 14, two formulas on p. 28 nd 30 were incorrectly printed and erefore meaningless. The correct ersions are as given below:

andomness:

$$= \pm \left(\frac{\sum_{i=1}^{N} y_i^2 - \frac{1}{n} \sum_{j=1}^{N/n} T_j^2}{\frac{N}{n}(n-1)} \right)^{\frac{1}{2}} \text{degrees/hour}$$

here y_i = a drift reading at any position,
T_j = the sum of the drift readings at a position,
n = the number of drift readings at each position, and
N = the total number of drift readings.

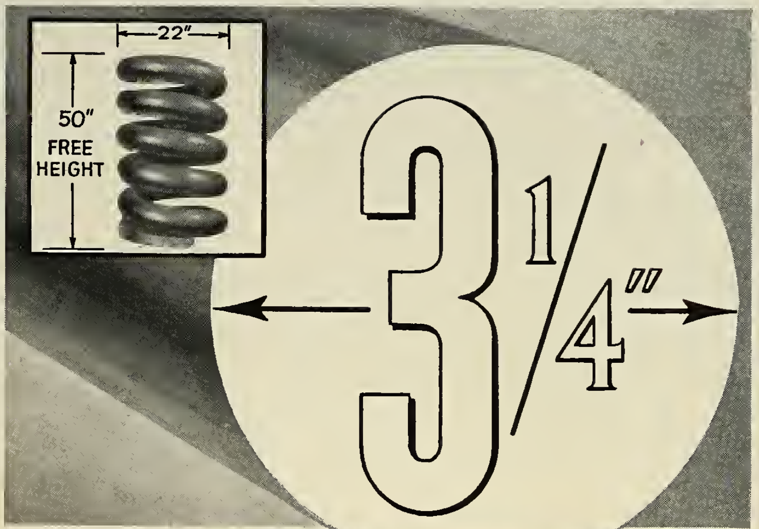
esidual Sigma:

$$\pm \sigma_r = \left(\frac{\sum (\widehat{y_i} - \overline{y_i})^2}{\frac{N}{n} - 1} \right)^{\frac{1}{2}}$$

ere $\widehat{y_i}$ = magnitude of fitted curve at a position, and
$\overline{y_i}$ = average of the drift readings at a position.

ONLY ASF HAS IT!

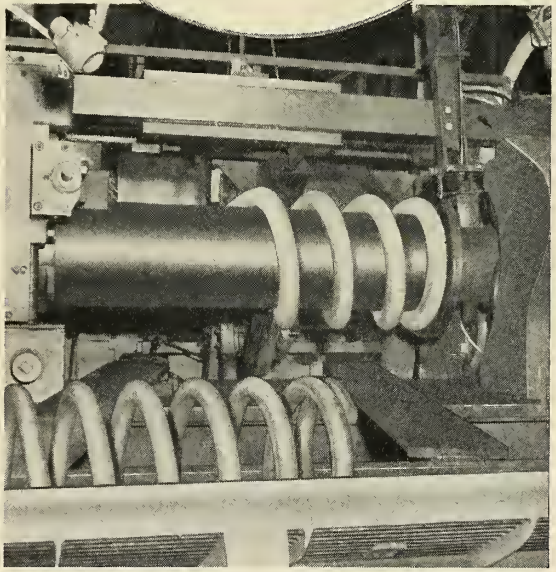
New machine coils 3 1/4" bar stock into 22" diameter springs for missile silos



Springs Pass Air Force Inspection

Quality production of the heaviest heavy-duty springs at ASF—HAMMOND Division took another giant step forward recently with the installation of this specially designed machine. It coils 3 1/4" bar stock into half ton springs with 50" free height. These springs are uniform in all essential physical characteristics.

This new machine automatically controls coiling time to minimize loss of temperature, which assures effective hardening. This results in new standards of uniformity in the heavier springs. If you have a shock-mitigation problem, why not write today for complete information.



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The Countdown

WASHINGTON

Pocket Operation

With the latest *Mercury* failure (see p. 17) knives are out in the Pentagon to cut the slipping civilian man-in-space program off at the pockets. ($241 million has been appropriated to date with another $100 million still needed.) Countdown hears a lot of speculation that the Kennedy Administration may kill *Mercury*. But it is also possible that the program could be incorporated into a greatly beefed-up space-flight effort, perhaps focused around the Air Force's *Dyna-Soar*.

Where's the Monkey?

Back in August, ARDC's Gen. Schriever said a primate would be sent into orbit in a *Discoverer XV* in mid-September. Now the Air Force is letting it be known that this long delayed shot is in the pipeline for "after Jan. 20." What happened? Some say the slippage was deliberate—to keep the AF from competing with *Mercury*, particularly before the election. Others contend technical problems and the fact that engineers were pulled off the animal capsule to work on *Discoverer XIII* made the shot impossible before next year.

Spotlight on Bambi

Rand Corp. will give ARPA a two to three day briefing shortly on prospects for the secret Project *Bambi* —ARPA's advanced study program for possible development of an anti-missile missile launching satellite. Subjects on tap: feasibility, cost and most attractive avenues of approach.

Booster Speedup Possible

Look for a speedup in the timetables for the *Nova* and *Saturn C-2* launch vehicles if the Kennedy Administration sticks to its pledge for a greater effort in space. A plan is now in the works to produce an early *Nova* scale model at NASA-Huntsville next year.

In the Pentagon

Close observers detect signs of a trend in the Administration-elect away from any radical shakeup in DOD organization—particularly anything affecting missile/space R&D . . . Plans now call for hanging four *Skybolts* on SAC B-52's, which could mean a production run of 2000 when the ALBM becomes operational—probably in 1964 . . . Date for the first full-scale *Minuteman* shot from a silo at the Cape is Dec. 12.

'Beetle Juice' Ahoy

Navy has converted a 12,000-ton cargo ship to haul operational Lockheed *Polaris* missiles to sub tenders stationed at Holy Loch, Scotland, and other advanced bases. The Betelgeuse—nicknamed the "Beetle Juice"—can tote 16 birds.

Pershing II vs. Polaris II—Cont.

Despite the denials of Defense Secretary Gates, the Army's proposed *Pershing II* is still considered in the running as a possible NATO MRBM. The Army is expected to mount a new push for the 1000-mile Martin missile, for its own use as well as NATO's, as soon as the Kennedy Administration takes office. Some insiders are speculating that Army R&D Boss Gen. Arthur Trudeau's recent trip to Western Europe may have included the gathering of ammunition in support of *Pershing II*.

INDUSTRY

Big Dyna-Soar Contract Due

Within the next few weeks—possibly before Jan. 1—the Air Force will award a large contract for the *Dyna-Soar* guidance system. The contract will be directly with the AF, making its recipient an associate rather than a subcontractor to Boeing.

Nuclear Rocket Facility

Any day now the NASA-AEC nuclear propulsion office will name a contractor for a four-month study of the master plan for a National Nuclear Rocket Testing Facility. Construction would begin in FY '62 and could be at the AEC's Nevada test site.

Ground or Orbit?

Word is out that Convair and Douglas are making studies (at $1 apiece) for NASA's RIFT (reactor in-flight test) plans. They are trying to help resolve the question of whether the first launch of a nuclear rocket should be from the ground or from orbit.

Look at the Enemy

A report by the American Society of Mechanical Engineers analysing the Soviet technological system finds these five "grievous" errors: "Russian management fails to recognize that one mind cannot possibly pre-guess the outcome of scientific venture. The Soviet tries to combine propaganda with progress. They have a dire shortage of individual imagination. Their scientists have to work under extreme political pressure."

INTERNATIONAL

Red Arms for Cuba

State Department study of the Russian beef-up of Castro's military forces shows Cuba has enough weapons for an army of 25,000. Items include 104,000 automatic weapons, 200 machine guns, 55 tanks, 100 3.5 rocket launchers—no tactical or long-range missiles.

French Space Shot

From its North African missile range at Colomb-Béchar France expects next year to launch a space capsule containing some small animals. Vehicle will reach an altitude of 900 miles.

The Long Road Ahead

How far is the U.S. behind Russia in sending biological systems into space? Taking a hard look at *Sputnik V*, ARDC's Gen. Flickinger believes the recovery of two dogs and other specimens in a capsule ejected from that satellite indicates a know-how in maintaining sea-level atmosphere and complex monitoring systems "at least 3½ to 5 years" ahead of the U.S. —even given the same payload weight right now.

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The Missile/Space Week

Decision on NATO MRBM Likely to Await Kennedy

Backing and filling during the last week over future NATO armament clearly indicated:

–A delay of possibly six months or more on deciding whether a specia NATO force armed with H-bomb-tipped, medium-range ballistic missile (MRBM's) will be created.

–A similar delay on a decision as to whether NATO nations will buy land based or seaborne *Polarises*—or possibly an alternative such as the proposed 1000-mile-range *Pershing II*.

Meantime, the Joint Congressional Atomic Energy Committee sent five of its members on a European tour to study the entire question of establishing a nuclear-striking force within the NATO Alliance.

Also, President Charles de Gaulle won a second vote of confidence in the French Assembly for his plan to establish a separate French nuclear striking force outside of NATO.

Previously the Eisenhower Administration had hoped that the NATO Council of Ministers could reach a decision on proposals for a NATO Strategic force armed with nuclear weapons when the Council meets Dec. 16 in Paris.

However, the Administration itself is understood to have failed to reach agreement on an American position. Therefore, the entire question is expected to be left for the new Kennedy Administration to handle.

First Polaris II Sub—Ethan Allen—Launched

Fifteen-hundred-mile-range *Polaris II* missiles will go on patrol around Russia early in 1962 aboard the 6900-ton Ethan Allen, first of the new class of FBM subs launched at Groton, Conn., last week. The Ethan Allen, the sixth *Polaris* sub to be launched, is 1300 tons heavier and 30 feet longer than the George Washington and her four sister ships. Nine pacifists were arrested at the launching. Two of them swam out to the Ethan Allen and boarded the bow as she slid out into the Thames from the Electric Boat Co. yard.

Hints on Red ICBM Bases, Antimissile Missiles

The Russians this week offered the world a few hints about their missile progress. But as usual they were open to question.

Hint No. 1 came from Andrei I. Yeremenko, Soviet Deputy Defense Minister. He implied in the official Soviet English-language publication *International Affairs* that Russian ICBM bases are "well camouflaged or hidden underground" and scoffed at the idea that high-flying reconnaissance planes could find them.

Hint No. 2 came from Marshal Vasilly Kozakov of the Soviet Artillery. He said in *Izvestia* that "Russian forces now have rockets which can hit offensive pilotless devices at great altitude."

Some observers speculated that hint No. 1 could mean that Russia has any number of hidden ICBM bases unknown to the United States, and that hint No. 2 could mean Russia has developed an anti-missile missile.

On the other hand, hint No. 1 could be merely bluster. And hint No. 2 could merely mean that Russia has finally developed a missile similar in capability to the Western Electric *Nike-Hercules*.

Alaskans Watch Nike-H Make History

Thousands of residents of Anchorage, Alaska, became the first city dwellers this last week to watch a *Nike-Hercules* go into action from an operational defense site set up to protect them from attack.

The *Nike-Hercules* ripped from an operational site near Anchorage on the slopes of the Chugach Mountains, leaving a long white trail in the Alaskan sky. It struck a simulated target 73 miles away.

allute Flies Again

Goodyear's *Ballute*, a re-entry recovery system, racked up its second traight success 170,000 ft. over the Air Force's Eglin Gulf Test Range last eek. The packaged nine-foot-diameter coated fabric balloon was released om the third stage of a three-stage *Cree* test missile ascending at a speed of ach 1.5. The *Ballute* popped into shape within a tenth of a second, stabi- zed the 500-lb. re-entry vehicle and then reeled out on a cable to gain the esired drag during the missile's final 35,000 ft. of ascent. A parachute, de- loyed when the vehicle's speed fell below the Mach 1 mark, completed the covery.

aking Ranger Germ Free

To insure that the U.S. won't be guilty of contaminating the moon, NASA planning to sterilize its *Ranger* lunar-landing space vehicle. Lockheed issile and Space Division last week received a contract for a prototype erilization gas transfer system. It will be used on the ground to pump a ixture of ethylene oxide and freon-12 gases into the *Agena-B* payload sec- on to render it germ-free. The fumigant will be flushed out and neutralized rior to launch.

artin Hints at Expansion

Martin Co. Stockholders will vote on a proposed 2-for-1 stock split Jan. 9. Company directors, who also increased the present quarterly dividend from 40 to 50 cents, indicated the increase in shares, if approved, would create a reserve which could be used for future acquisitions to diversify the corporation. Three million of the company's 6 million shares are now outstanding. The split would increase the no par capital stock to 12 million shares.

Polaris Weathervane

ORD ON Bayshore Freeway tests Po-
ris performance at subsonic speed (60
ph). Missile model hangs from car
indow. Lockheed is gathering data on
hat happens to pieces when bird blows
in flight. "Weathervane" of car wind-
ream gives answers.

Solar Pressures Squeeze Echo

The orbit of the Project *Echo* balloon has taken a more elliptical shape due to solar pressures.

The satellite's apogee is now approximately 1290 miles. Its perigee is 666 miles and is dropping about three kilometers per day due to solar pressures.

The balloon is estimated to be about 60% to 70% inflated. Its radio reflecting quality is still good, according to Jet Propulsion Laboratory technicians at Goldstone Lake, Calif.

The *Echo* vehicle has been visible for a few minutes during recent midnight passes and is beginning to work out of the "shadow" area of current orbit. It should again be visible in about two weeks.

The primary power supply for the beacon has apparently failed and the olar cell standby system is providing power for intermittent transmissions hen cells collect sufficient power.

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Transit May Beat Schedule

System Could be Operational before 1962

- ***First two shots performed well, accuracy problem seems to be solved***
- ***Transit 3-A launching expected in near future; several more R&D shots to come will check auroral zone***
- ***Principal remaining problems are in improving knowledge of geodesy, life-testing component reliability***
- ***Hardware for operational version—much smaller—is being developed***

by Hal Gettings

NAVY'S *TRANSIT* navigation satellite program may move ahead of schedule if its success record continues.

Although no one will make any official guesses, performance and data gained from the first two *Transits* ndicate that it may be possible to cut short the R&D phase and get the operational system in the air sooner than the planned 1962 target date.

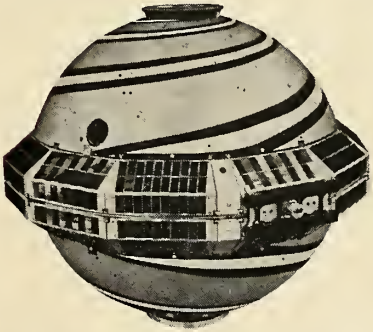
Scientists at Johns Hopkins Applied Physics Laboratory—the Navy's system contractor—feel that the big problem of accuracy has already been solved. Refraction error corrections—the biggest unknown in the development phase—have been checked out and verified. The better-than-½-mile accuracy goal of the R&D satellite has been confirmed in several different ways, including cross-checks with optical sightings.

Dr. Richard Kershner, director of APL's Space Development Division and chief of the *Transit* program, says that he inherent measurement accuracy of he system is even better—that accuracies of 1/10 mile for the operational system are realizable. Practical utilization of such pinpoint accuracy is, of course, predicated on expected advances in geodesy over the next few years.

• **Accomplishments to date**—Both *Transit 1-B* and *2-A* have performed well and yielded considerable significant nformation. Primary purpose of *1-B* was to check out refraction error determinations. This was done by simultaneous comparison of the refraction of two different frequencies. Measurements were confirmed by another pair of frequencies, as well as by the optical cross-check.

These tests were considered conclusive except that no measurements have been made in the auroral zone or during periods of intense auroral activity. Such measurements will be made with subsequent R&D vehicles. These will probably require receiving and tracking stations at near-polar locations and monitoring over a 3-4-month period.

Because of *1-B*'s lower altitude, some question remained as to the validity of refraction measurements. *Transit 2-A*, with its higher orbit, resolved this question and quieted critics.



R&D TRANSIT has band of solar cells and painted spiral antennas (white lines). In smaller operational model, most of surface will be solar cells, different type of antennas will be used.

Consensus is now that refraction in medium latitudes and under most conditions is no problem.

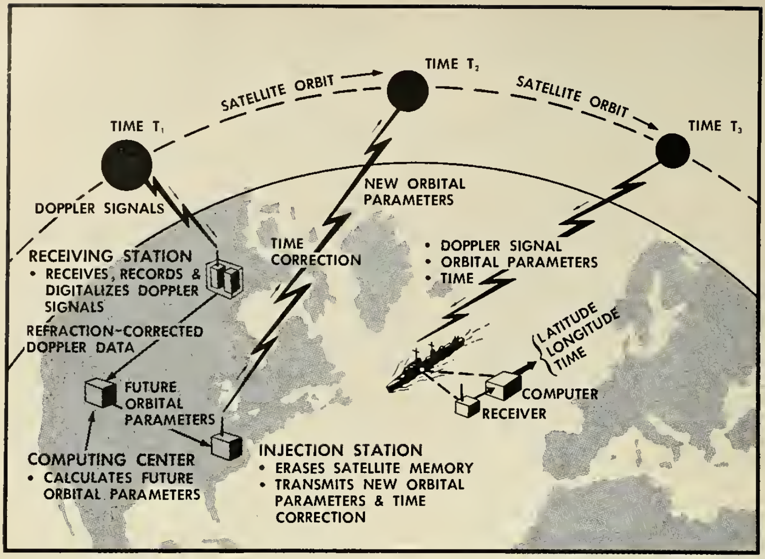
The next shot in the series, *Transit 3-A*, is expected in the near future. Navy will not say exactly how many more R&D satellites are planned. It is known, however, that several—possibly as many as six—are on the schedule. Final number will depend on how much necessary information is gained from the next few vehicles in orbit.

Transit 2-A is being tracked by seven ground receiving stations in addition to the headquarters station at APL, in Howard County, Md. Three of these are located in Continental U.S.: Austin, Tex., Seattle, and Las Cruces, N.M. Van-mounted stations are located in Argentia, Newfoundland, and near Ottawa, Canada. A sixth station is at Lasham, Hampshire, England, and a seventh at San Jose dos Compos, Brazil.

• **Some problems remain**—The potential accuracy of the *Transit* system is greater than present knowledge of geodesy—including gravitational characteristics—will allow us to use. Considerable research is necessary in this area before projected accuracies can be utilized. Coming out of such research will be more exact knowledge of the earth's shape, distances between land masses, and of the gravitational field. Consequently, the big effort in the program during the next year will be in extending the ground station network and determining by long-period tracking the solution to the geodesy problems.

• **Operational hardware in development**—Work has already started on hardware development for the operational version. Dr. Kershner says it is "going well" and on schedule. Primary emphasis is on the development of a suitable memory unit for the satellite. This must be simple, cheap, small, and reliable. Early R&D models used a magnetic core, but this is not considered suitable for the operational system. Best prospect so far, according to informed sources, is a magnetostriction delay line for the memory function. Although such a device has yet to be proved out completely, it looks particularly good for the intended use.

• **Operational system smaller**—The operational *Transit* satellite will be



DOPPLER SIGNALS received from Transit at T_1 are refraction-corrected and used as the basis for calculating future parameters. The injection station transmits time correction and new orbital parameters to the vehicle (T_2), which retransmits the data (T_3) to ships or aircraft to yield navigational position.

considerably smaller and quite different from the research model. Weight will be 50-100 lbs. as compared with 223 lbs. for *2-A*. It is understood that the external configuration may not necessarily be a sphere, due to technical considerations, although such a shape would appear to be preferable.

A resulting smaller surface would obviously necessitate several differences in the antenna and solar cell arrangement. Most of the exterior area would be required for solar cells; therefore, the painted spiral antennas of the R&D vehicles would not be used.

Other changes include elimination of weighted de-spin yo-yos in the operational models as well as in later R&D satellites. A malfunction in the operation of the yo-yo in *2-A* showed that they were not necessary; the magnetic dampers were able to despin the vehicle down to less than one rpm.

The biggest difference between operational and R&D models will be in the payload. Redundancy will be virtually eliminated. The operational version will carry only one oscillator and two transmitters. Improvements in the reliability of batteries will make possible a lighter weight power storage unit. R&D instrumentation will not be necessary.

• **Reliability a problem**—The expected five-year life of operational satellites puts a heavy load on reliability requirements. Due to space and weight limitations, redundancy can be used only to a limited extent. However, previous experiments have shown that outer space is not an unfavorable environment for electronics. Not too much trouble is anticipated.

A question does remain as to techniques for life-testing components to determine their reliability over such a long period. Acceleration of some life tests is impossible and choices will have to be made on the basis of shorter-term reliability. The philosophy seems to be that if the best components available are put together with the best techniques known in the simplest circuitry possible, there is a fair expectancy of high reliability. There is no gold-plating in *Transit*.

Electronic circuitry will be completely transistorized. Nickel-cadmium batteries will probably be used, since they appear to be the best bet for high reliability under the charge-discharge cycling requirement of satellite application. It's hoped that previous problems experienced with this type will be solved in the near future, as a result of intensive studies now going on.

• **Launched by Scout**—A big bonus of the lighter payload weight will be the use of smaller and cheaper boosters to put the satellites in orbit. Such boosters as the *Scout*—or later models becoming available by 1962, such as the NASA *Super Scout* or Air Force *Blue Scout* with guided upper-stage—will be sufficient for the mission. The Navy has not yet indicated what its choice will be.

• **Operational system**—The operational *Transit* system will consist of four—or possibly more—satellites simultaneously in 500-600 mile orbits around the earth. Each satellite is expected to cost about $1 million t launch. System costs will run about $ million per year, based on a five-yea life. To keep the four satellites in th air will require an average of 1½ launches per year. The balance of th annual costs will go for ground statio installation and operation. The Nav will foot the bill for the entire program

Radio frequencies for the operational system have not yet been dete mined. A request has gone in to FC for allocation of 162 and 324 m bands, but no assignments have bee made at present. Final hardware development cannot proceed beyond certain point until frequency assignments are confirmed.

• **Military plus civilian benefits**—Although the primary purpose o *Transit* is to provide a precise navigational aid for *Polaris* submarines, th Navy expects to use it also for surfac craft. In addition, civilian ships an aircraft will be able to use the system Costs of the required receiving an computing equipment will be relativel small.

No *Polaris* submarines have ye been equipped with *Transit* receivin and computational equipment. An experimental system is being used aboar the missile test ship Observation Islan to track R&D vehicles. Data from th satellite is not used to actually navigat the ship, but the Doppler shift is recorded and plotted to determine jus how accurately it could have navigate with *Transit* data.

With four satellites in orbit, navigational fixes can be obtained anywher on earth on the average of once ever hour and a half. Data received fron the satellite, based on the Dopple frequency shift, will provide the navigator with all the information he need to precisely plot his position withi a few minutes. A basic receiving system, without the computer, will allow manual plotting within a period of tw or three hours—sufficient for mos merchant marine use.

Based on tracking information received by ground stations and reduce at a computing center, precise orbit and error corrections will be determined on a continuing basis. Data wil be fed back to the satellite to correc its transmitted information. In addition tables of correction information will b issued periodically to users.

The concept of using the Doppler shift of a satellite radio signal fo world-wide navigation was first proposed by Dr. F. T. McClure of APL Two other APL scientists—Dr. W. H Guier and Dr. G. D. Weiffenbach—earlier conceived the possibilities o such a system when they first use Doppler tracking to determine the orbits of other satellites.

olka-Dotted 'Baby Echo' o Explore Upper Atmosphere

by Jay Holmes

A 12-FT. "BABY ECHO" balloon ainted with white polka dots will be he first satellite launched by the all-olid *Scout* vehicle, possibly next week.

Langley Research Center, National eronautics and Space Administration, uilt the balloon, which will measure ensity of the upper atmosphere. ensity can be calculated from the rag it imposes on the satellite.

The balloon will use a four-ply andwich material, made up of two ayers of Mylar and two thin deposits f aluminum, with total thickness of mils—about four times the thickness f the wispy aluminized Mylar used or *Echo I.*

The air-drag satellite, designated *-56,* will be the first satellite launched rom NASA's Wallops Island station. lthough the *Scout* satellite is an outrowth of the *Echo* passive communicaions satellite, no communications exeriment is planned for the smaller alloon.

However, the stiffer material will ndergo a test in the 12-ft. balloon that nay lead to its use in a larger comnunications balloon satellite later in he year. A major drawback of *Echo* or communications relay is the fact hat its surface is no longer permaently smooth and signals reflected are o longer perfect. NASA engineers ope the stiffer material may overcome his difficulty.

• White for reflection—The *Scout* alloon will have 18% of its surface ainted with white polka dots to reflect olar heat and maintain the internal emperature at the desired level. The acking beacon will be powered by our solar cells, located about the phere in the shape of a regular tetraedron so that at least two are always sunlight.

The initial orbit is programed for a ominal apogee of 1094 miles and a erigee of 370 miles.

Meanwhile, NASA sources indiated that from four to six major unchings will take place in Decemer and possibly seven more have target ates in the first quarter of 1961. ASA spokesmen emphasized, howver, that none of the dates are firm.

The air-drag *Scout* satellite will robably be the next to follow last eek's *Tiros II* and *Mercury MR-1* unchings. Also likely in December re *P-31*, the *Atlas-Able* lunar orbiter; and *Mercury MA-2,* an *Atlas* ballistic test.

• Some slippage—Also on the tentative December schedule were *Mercury MR-2,* the ballistic shot with a chimp in the capsule, and *S-45,* the ionosphere beacon satellite to be launched by a *Juno II.* But NASA Administrator T. Keith Glennan left them out of a list he gave on a television program Nov. 20, indicating they have slipped into January at least. An interplanetary magnetic-field probe, *P-14,* to be launched by a *Thor-Delta,* also had been scheduled for December but has slipped into the early months of next year.

NASA's Tentative Schedule

December, 1960

Mission	*Launch Vehicle*
Mercury MA-2	Atlas
Mercury MR-1	Redstone
Lunar orbiter P-31	Atlas-Able
Air density S-56	Scout
First Quarter, 1961	
Ionosphere beacon S-45	Juno II
Mercury MR-2	Redstone
Tiros backup	Thor-Delta
Mercury MR-3	Redstone
Mercury MA-3	Atlas
Micrometeorite S-55	Scout
Interplanetary P-14	Thor-Delta
Gamma ray S-15	Juno II
Mercury MA-4	Atlas
Mercury MR-4	Redstone

Other shots tentatively in the first quarter are *S-55,* a micrometeorite hazard measuring satellite, to be launched by a *Scout* from Wallops Island, and *S-15,* a gamma ray astronomy satellite, to be launched by a *Juno II.*

A number of *Mercury* launchings also are to take place in the first quarter. For the purpose of contractor delivery and planning, NASA has scheduled two *Mercury Atlas* tests and two ballistic manned flights.

For the remainder of the year, 24 major launches are programed. These include eight *Mercury* launches, five scientific satellites, four deep space probes, three *Centaur* vehicle tests, one *Saturn* booster test and three backup vehicles. ⁂

Blow for Mercury

Surprise Failure Adds To Delay in Program

WITH ALL SEVEN astronauts looking on, failure in the supposedly reliable *Redstone* booster rocket caused another indefinite and embarrassing delay in the slipping *Mercury* man-in-space program.

Spokesmen for the National Aeronautics and Space Administration declined to speculate on how much time was lost by the Nov. 21 failure, but it is believed that the first manned ballistic flight now will come on April 15, 1961—at the earliest.

The *Redstone* shut down for some unexplained reason a few seconds after ignition for its first test lift of a production McDonnell capsule. As programmed, the escape tower then jettisoned itself and landed in a sand and palmetto area about 1200 ft. west of the *Redstone* pad at Cape Canaveral. The booster and capsule remained on the pad.

The tower was to have jettisoned on the conclusion of powered flight, at 35 miles altitude, 140 seconds after liftoff. The abort sensing system was being tested only on open loop. The escape system could only have been operated by ground command.

The LOX was vented and the alcohol propellant was drained by the following day, making possible a detailed examination of the booster and capsule to determine what went wrong. There was no explosion and both appeared undamaged.

• Troubles mount—The failure was the third in a row for the ill-starred *Mercury* program. Last July 29, an *Atlas* exploded during the test lift of a capsule about 65 seconds after launch. The cause was never established.

On Nov. 8, the escape system failed to operate in a *Little Joe* flight from Wallops Island, Va.

George M. Low, NASA chief of manned space flight, said the prospects are better for determining the cause of the *Redstone* shutoff because intact hardware is available for examination. A new flight will be scheduled, he said, when the trouble is found and fixed.

By late last week, NASA spokesmen said they were zeroing in on the *Redstone* trouble and a new flight would be scheduled in a matter of weeks.

The second *Mercury Atlas* is on the pad for launching next month. It will be a repeat attempt to perform the experiment programed for MA-1, the July shot. This called for a lift to an altitude of 110 miles followed by a sharp re-entry angle, leading to a splash only 1500 miles downrange, subjecting the capsule to as many as 16 g. ⁂

X-15 Moves Nearer Space Flight

Powerplant has yet to be 'given its head'

- ***New XLR-99 engine will test man's reaction to space-equivalent conditions***
- ***Biomedical instrumentation package telemeters and records vital data on the pilot's physical condition***
- ***Second-generation pressure suit giv complete protection in a single layer, pr vides relatively good mobility***
- ***Modified checkout and dressing van model for other programs***

by Heather David

WITHIN A FEW MONTHS, the biggest man-rated engine capable of reaching near space will be put to its first full-capacity test.

In its first two flights, the Thiokol XLR-99 engine recently installed in the *X-15* performed admirably. Scott Crossfield, North American Aviation test pilot, flew the plane to a 50% capability. His contract prevents him from making a full-velocity test run with the 57,000-lb.-thrust engine.

In the second flight on Nov. 22, the XLR-99 demonstrated that it could stop and restart in flight. Crossfield shut it off for 15 seconds, then restarted it and ran it for another 75 seconds.

Only when the *X-15* is turned over to government pilots will it be flown to new records of speed and altitude.

Even then, in many ways the flight will not be new. The first full-powered flight will have been "flown" before—in a centrifuge, in a heat chamber, in an altitude chamber. The *X-15* is probably the most thoroughly tested man-machine system for astronautical research. *Dyna-Soar, Mercury* and their successors will bear marks of the life support systems in the *X-15*.

Lt. Col. Burt Rowen, Human Factors Coordinator for the *X-15* program, Capt. R. N. Richardson and the 16th Physiological Training Flight and the AF flight surgeons have had to prepare for many of the emergencies of spaceflight. Among them have been altitudes exceeding 130,000 ft., g-loads up to 7 or 8 g's, possible radiation exposure, and—sometime early next year—periods of weightlessness lasting several minutes.

In spite of much talk and extensive research in bioinstrumentation, the biomedical telemetering system used in the *X-15* is the only human operational system of its kind. The pilot's respiration, skin temperature, EKG (electrocardiogram) and helmet and suit pressure have been recorded on on-board oscillographs and telemetered during flight.

• **Miniaturization sought**—Several study contracts have been let for a compact blood pressure sensor. An arm-type cuff has given very good results in the TF 102 trainer, but space is at a premium in the *X-15*. In spite of the difficulty of getting a blood pressure reading remotely, the Air Force is still interested in finding a way, according to the Coordinator.

Col. Rowen told M/R that the current biomedical package, which measures 5 in. x 6.5 in. x 11.5 in, will soon be installed in the No. 2 plane, which carries the new 57,000-lb.-thrust engine. This plane, powered by Thiokol's XLR-99 engine, will carry man to over 4000 mph at altitudes above 100 miles.

Contracts are now being negotiated to miniaturize the package, according to the Human Factors Coordinator. Several companies have submitted bids—among them Texas Instruments and North American, who built the original package. Also under scrutiny is a printed circuit-type system developed by Lt. Pulanski of Edwards AFB. This package measures only 1/3 of the original system.

Although the *X-15* pilots have not yet encountered any harmful radiation, with the proposed altitudes of the new plane there is always that possibility. By the first of the year a radiation monitoring and detection device, especially developed for the *X-15* by the AF Special Weapons Center, will be installed in the cockpit of one of th planes.

All the pilots have undergone base-line count of body radiation. Aft flights of any altitude, the pilot mu undergo a whole body radiation cou at Los Alamos.

All new instrumentation and pre sure suits will first be extensively teste in the TF 102 used as a trainer f *X-15* flights.

• **Fast-change suit**—Now underg ing evaluation in the TF 102 is a "se ond-generation" pressure suit whic will replace the cumbersome MC- suit now used. Contrasted to the fou layer garment which took 20 minut to put on, the new suit is one piec and can be donned in minutes.

The changeover from the old su will coincide with the turnover of th new engine to the government pilot says Col. Rowen.

Unlike the *Mercury* suit, both *X-1* suits use nitrogen to maintain pressur in the lower part of the suit. Oxyge fed into the helmet is kept at a highe pressure than the nitrogen to preven any possibility of escape of nitroge into the sealed helmet. B-52 oxyge is breathed until just before the *X-1* is launched.

Another improvement in the ne suit is the change in the helmet fac plate from a clear plate to a heated gold-tinted material which prevent fogging or icing.

One of the most important phase of the training for *X-15* flights has bee in the centrifuges at Aerospace Medica Laboratories, Wright-Patterson AFB, and at the Navy's Aviation Medical Acceleration Laboratory at Johnsville, Pa.

The *X-15* controls were linked by electronic devices to the centrifuge, making it possible for the *X-15* pilot to

ABOVE: *Maj. Bob White leaves X-15 after recent run at Edwards AFB. Man beside him holds portable cooler plugged into suit.*

fly" the centrifuge on *X-15* flight lans. Since the first flights in 1957, lmost every kind of emergency and ight condition has been simulated, ncluding flight with the bigger engine.

Since the *X-15* pilot cannot recline) resist g forces, his ability to ride ut high g's—perhaps as much as 7 or —must be supplemented by a g-suit. he MC-2 suit, and the new suit, has built in g-suit. An accelerometer iggers the inflation of bladders around ie thighs, calves and waist. This keeps ie blood circulating in the upper part f the body so that the pilot doesn't lackout.

The new suit is also made by the avid Clark Co., Worcester, Mass., evelopers of the MC-2. Each suit is ilormade and covered with a mesh-ke fabric allowing bending. But, since e *X-15* pilot sits during flight, the it is curved in the back and legs so at he won't be straightened out under ll pressure. Hence, he has a crab-ke walk.

The Bendix Co. and the Air Force ve developed a portable heat breaker hich the pilot can carry while wait-g to get in the plane. Since the suit airtight, the heat generated by the an's own body could weaken him minutes.

Although the cooler was developed r the *X-15* program, the Air Force ys this device also can be used on her programs.

• **Laboratory on wheels**—The 30 by 9 ft. support van designed by pt. R. N. Richardson and the 16th ysiological Training Flight has been successful that the idea has been nployed in the *Discoverer* and *ercury* programs.

Before each flight, the air-condi-ned van is parked next to the B-52 mother ship. The pilot gets a complete checkout in his suit for anti-g, pressurization, oxygen, ventilation and communication.

The 16th Physiological Training Flight, commanded by Capt. Richardson, has been credited for its work in the *X-15* program. The Flight has been responsible for the van, and the pressure chamber tests of the suits and pilots. In August, the month Maj. Bob White flew the altitude record, the 22-man Flight put in 260 man hours in support of the *X-15* program alone.

• **Escape**—The problems of escape from a crippled vehicle at supersonic speed have been all-too-well illustrated in a recent jet accident. Fortunately for the pilot, the air was relatively calm. Nevertheless, although he lived he suffered mass hemorrhaging from q force or dynamic pressure.

The *X-15* escape system has been designed so that the pilot initiates seat ejection. To avoid the q force impact, he must wait until the plane slows to below 600 mph.

Although there has been some theorizing about the value of capsule ejection for future flights, Scott Crossfield is reported as saying that he felt just as safe sticking with the plane until it slowed down.

During every flight an H-21 helicopter is stationed near the landing area for medical support. A flight surgeon, who also serves at the base hospital, rides in the helicopter and meets the pilot. A flight surgeon and ambulance are also assigned to the launch area, the intermediate emergency area, and landing area for each flight. Four fire trucks line the landing field. ⁂

X-15s Nov. 16 Flight Plan with XLR-99 Engine

1. Launch SAS 4-4-8 Ignition 70%, reduce to 50%.
2. Accelerate & Climb to 2.0 Mn at 50K.
3. 1.2 Mn Open Speed Brakes.
4. 47K 1.8 Mn .5g pushover to level at 50K.
5. 50K 2.0 Mn 2.5g space positioning turn.
6. 20 sec. fuel remaining. Pullup to 2.5-3g to 20° θ. Pushover to .00g or slightly positive and hold to burnout. Note: Do not exceed 300 FPS rate of climb above 65K.
7. Burnout (Approx. 58K at 2.3 Mn). Close Speed Brakes.
8. Head EAFB 70° banked turn ($\alpha = 12°$) max. alt. 78K. Burnout above 58K or 2.3 Mn—full deflection steady sideslip to the right.

   OR

   Burnout below 58K or 2.3 Mn—full deflection steady sideslip to the left.
9. Glide 30K and .95 Mn SAS 4-4-8 4.00g momentary pullup. All SAS OFF pitch & yaw pulses.
10. Jettison at Chase request. Stop H2O2 at 800 psi source.
11. Downwind—Lake alt. & wind. Check ventral arm—pressurize tanks. Base leg SAS 2-4-8, Jettison ventral, landing gear osc ON Flaps, gear and LAND.
12. Landing Slide. SAS OFF.

Plan for Second Flight with XLR-99 Engine

1. Launch SAS 4-4-8 Ignition 70%—Retard to 65% if thrust oscillations are encountered.
2. $\alpha = 10°$ during roundout at 43K
3. Accelerate & climb to 2.0 Mn at 50K ($\alpha = 10°$)
4. 1.2 Mn Open Speed Brakes
5. 45K .5g pushover ($\alpha = 2.5°$) to level at 50K
6. 50K 2.0 Mn 3.2g space positioning turn ($\alpha = 12°$)
7. Rollout of turn (Mag heading = 320°), Hold 3.2g
8. Maintain $\theta = 20°$ to burnout
9. Burnout (Approx 56K at 2.75 Mn) Close Speed Brakes
10. Head EAFB 70° Banked Turn ($\alpha = 10°$) Max alt = 73K
11. Glide 30K & .95 Mn SAS 4-4-8 4.0g momentary pullup ALL SAS OFF Pitch & Yaw Pulses
12. Jettison at chase request. Stop H202 at 800 psi source
13. Downwind—Lake Alt & Wind Check Ventral Arm—Pressurize Tanks Base Leg—SAS 2-4-8, Jettison Ventral Landing Gear Osc—ON Flaps, Gear & Land
14. Landing Slide

U.S. Army may choose soon . . .

Foreign Firms Seek Antitank Sales

Seven manufacturers in Europe and Australia offer nine missiles with widely varying characteristics; light weight vies with kill power

SWEDISH SOLDIER ready to fire a French SS-10. The Nord Aviation antitank missile is used by both Land and Naval forces in Sweden.

by Bernard Poirier

THE FIERCE INTERNATION scramble among missile manufactur who want a share in the antita market has been joined by Pye, Lt of Royston, England.

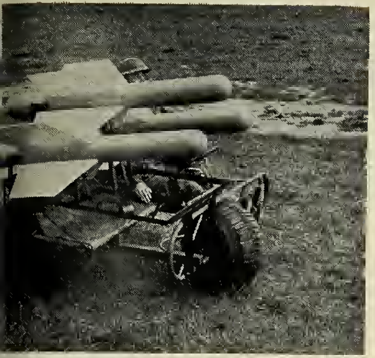
(COUNTDOWN on Nov. 14, reveal the hot competition to win the U Army's nod for an antitank syste After several months of evaluation, t Army may now be near a decision.)

With several NATO nations, cluding the U.S., in a buying moc British firms like Pye and Vickers to advantage of the recent Farnborou Exhibition to display their weapons greater detail than previously.

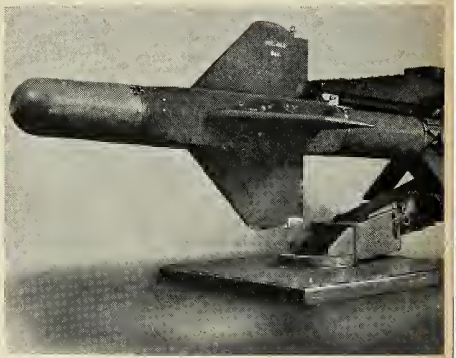
In all, seven foreign companies some with U.S. affiliations—from fi European countries and Australia a offering nine missiles for consideratic Among the makers, the *Cobra* man facturer has a license agreement wi Daystrom, Inc., and the French man facturer of the *SS* series has at lea a tentative license agreement with Ge eral Electric. The Government Aircra Factories (of Australia) have made similar move with Fairey Engineeri for European sales of their *Malkara.*

The nine missiles involved can divided into five basic categories a cording to weight. The true antitar "featherweight" is the Swedish *Banta* weighing in at 13 lbs. Three "ligh weights" are the 20-lb. *Cobra* Boelkow Entwicklungen, the 23-l *Mosquito* (*Cobra IV*) by Contrave Oerlikon and the 26-lb. *Vigilant* Vickers-Armstrong. Because of the common conception, the *Cobra* and th *Mosquito* are quite close in final co figuration.

The sole "middleweight" is th 33-lb. *SS-10* offered by Nord Aviatio S.A. of France. "Light-heavies" ar the 80-lb. Pye *Python* and the 62-l Nord *SS-11*. The real haymakers ar the Nord *SS-12* at about 150 lbs. an the Government Aircraft Factor *Malkara Mk. 1* at 206 lbs.


EXCLUSIVE M/R photo of Pythons in motorcycle concept by Belgian firm.

MAN-PORTABLE Vigilant under evaluation by British Army is highly accurate.


FIRST REPORTS on Australia's Malkara Mk. 1 indicate easy repair despite weight.

• **Boelkow, Nord experienced competitors**—The *Python,* latest to reach the evaluation status, joins the *Bantam, Mosquito, Vigilant,* and *SS-12.* Already operational are the German *Cobra,* the Australian *Malkara* and the French *SS-10* and the *SS-11.*

Most of the competition is reportedly centered between the light *Cobra,* with a range of about one mile, and the heavier, longer-range *SS-11.* The German bird uses plastic construction wherever possible to lighten the round and enhance its advantage of easy portability in any terrain. The *Cobra* warhead weighs only 5.5 lbs. and the missile, like all other original missile models, is wire-guided.

In an attempt to offset the portability acclaimed by *Cobra* users, the French have developed and tested wireless guidance and optical guidance with infrared scanners. Nord has also come up with an attractive Waist Belt Fire Control well adapted for use in rugged terrain, (M/R, Aug. 29, p. 49). The *SS-11* has been fired from aircraft, helicopters, torpedo boats and tanks to prove its versatility.

Other manufacturers are not sitting idly by to be outdone in originality. Vickers recently illustrated the use of the *Vigilant* under combat conditions with airborne parachute troops. The missile is lightweight enough and durable enough to take the roughest handling and remain dependable.

• **Bigger parts, easier field repairs**—Alan S. Hulme, Minister of Supply for Australia describes the *Malkara* as "a weapon of uncanny accuracy and extremely high lethality." It has been test-fired from light and heavy vehicles, motor torpedo boats and landing ships. It is a two-stage solid-fuel weapon with a boost acceleration of 20 g's and a range of over 12,000 feet.

The *Malkara* features easy interchangeability of major components, accessibility of internal components, and steel clamp rings of the U-section to join the mating parts of the body, providing a joint which can be quickly assembled by one man.

The Australians designed the missile to be robust enough for use throughout the range of climatic conditions.

In the fire control field, however, Nord has developed several separate module concepts with which several different *SS* models can be integrated in one missile battery. Nord is the most experienced manufacturer in the field; its *SS-11* has been widely accepted and is in use in a dozen countries. Continuous activity by Nord has produced an effective minimum range of 550 yards for the *"11"* and—when wire-guided—a maximum range of 3830 yards. Antitank weapon makers realize that minimum range is a very important consideration for some battle conditions.

West Germany gave the French company a big boost in prestige when it ordered a substantial number of *SS-11* missiles. However, West Germany still has use for the *Cobra 1,* manufactured in Germany. This missile was actually conceived by the Swiss firm Contraves-Oerlikon, which explains the similarity of many characteristics of the *Cobra* and the *Mosquito.*

The German *Cobra* remains one of the best entries on the market. The world-famous German initiative was liberally applied to the technical concept of the weapon, making it one of the lightest, most reliable weapons for many battle conditions. It is easily carried or fired by one man. Germany has sufficient production facilities (and others are possible elsewhere) to provide reliable missiles in large numbers at a relatively low cost, sometimes quoted around $1000 per bird.

The German weapon's weight and low cost are attributed in large part to extensive use of plastics. Its fins, for instance, are of foamed styrene covered by fiberglas—a material widely used in its body as well. It is slower in flight than the *SS-11,* whose propelled duration is 22 secs. But the *Cobra* is under power for a longer period over a shorter range, and hence seems to have a proportionally longer period of controlled maneuverability under propulsion. The *Cobra* needs no launching apparatus for land deployment.

There have been some reports that the *SS-10* and the *SS-11* cannot be fired over water. But the reverse is true: armed forces of several different countries have successfully fired both missiles at sea targets from land sites and from vessels under way. Moreover, these tests were so satisfactory that Sweden plans wide deployment of the *SS-11* on patrol ships and Nord is currently developing a new version for special naval applications.

• **Motorcycle weapon last used in 1917**—In describing the versatility of the *Python,* Pye has revealed the newest application of a mobile missile platform. Three missiles can be fired from a motorcycle, and several vehicles manufactured by Fabrique Nationale de Liège, Belgium, have been converted for this purpose.

The British firm summed up what many missile makers are trying to prove when it said, "The size of the *Python* has been chosen as the best compromise between the requirements of a very high chance of kill from each hit, (these can result in large warheads, heavy and complicated missiles and ground equipment) and mobility, coupled with simplicity and economy."

Some other manufacturers argue that light weight is the decisive factor because it enables the operator or gunner to more easily get a good firing position in any terrain in order to get a shot off. But still others claim that the most important factor is destructibility—which necessitates a heavier warhead, thus a heavier missile.

There are other questions to be argued: shelf life, versatility, dependability, rough handling, etc. The battle goes on and on. ⌘

Technical Countdown

ELECTRONICS

New Lab To Study Nature of Light

The nature of light will be studied in a photo-optronic laboratory now being constructed by The Electrada Corp. Reported to be one of the first commercial undertakings of its kind, the lab will be equipped to perform precise measurements of physical and chemical effects of light within the microsecond-micron range. Special devices will be installed to study the effect of light upon crystals and photo-conductors.

Nickel-Cad Batteries Improved

Several improvements are being made in nickel-cadmium batteries to better fit them for their anticipated role in the operational *Transit* navigation satellite. Two areas of previous trouble—leakage and breakdown of paper separators—reportedly have been solved. Other improvements are being studied to insure the required five-year operational life.

Photo Pickoffs Now Seen Practical

New materials and circuit designs may lead to practical use of photoelectric force and motion transducers for missile applications, says White Avionics Corp. In the past, there have been problems with long-term stability and large displacement required by sensors. Now, control of light source for long periods is accomplished by maintaining a tungsten element at low temperature and providing feedback control from a photo-conductive diode. Semiconductor advances permit significant improvements in miniaturization and reliability.

GROUND SUPPORT EQUIPMENT

New AMR Range Vessel Added

The Twin Falls Victory, a precision-radar tracking ship, has been added to the Atlantic Missile Range fleet. New equipment will allow the $10-million ship to make absolute trajectory measurements referred directly to the launch pad rather than to the ship itself. First missions will be in *Polaris* and *Pershing* programs.

Solar-Storm Data Being Checked

Naval Research Lab. scientists are hopeful that the *Greb* radiation satellite—which rode piggyback into orbit with *Transit II-A*—will yield some pertinent data on the recent intense solar storm. The satellite passed over the Blossom Pt., Md., station just before and after a flare and no change in X-ray or Lyman-alpha radiation was observed. Tapes from other tracking stations have yet to be analyzed.

Water by 'Electrodialysis' for ICBM Bases

Electric-membrane desalting units will supply pure water for *Titan* and *Atlas* hard bases in New Mexico, South Dakota, and Oklahoma. The Air Force has ordered twelve of the Ionics, Inc., units—costing close to $1 million—to desalt highly mineralized local water for base use.

'Tall Tom' Almost Ready for Air Test

The preproduction prototype of the Air Force AN/ULD-1 Electronic Reconnaissance System (Tall Tom) is scheduled for installation in its airborne test vehicle soon. The $20-million highly classified program—in being almost three years—is now completing its bench-test phase.

Little Things Add Up

Approximately 2100 miles of wire and cable will b used in the 150-missile *Minuteman* base at Malmstron AFB, Mont. Wire and cable cost is expected to run close to $12 million.

PROPULSION

New Cooling Method for Nuclear Rocket

Regenerative cooling with liquid hydrogen isn't sufficient to keep temperature of a nuclear-rocket nozzle down to the desired level of 1440°R, a NASA study has found Indications are that regenerative cooling will be supplemented by high pressure drop, high wall temperature, refractory wall coatings, thin highly conductive walls, film cooling or a combination of several such methods.

A-2 2nd-Stage Propellant In Production

The Naval Propellant Plant at Indian Head, Md., is going into production on the double-base propellant for the high-energy second stage of the 1500-mile A-2 *Polaris* Propellant will be shipped to the Hercules Powder Co plant at Bacchus, Utah, for pouring into fiberglass-plastic cases.

ADVANCED MATERIALS

High Yield From Modest Input

More than $150,000 worth of valuable metals is reclaimed each year by Varian's five-man reclamation department from klystrons and other tube subassemblies Varian says the figure actually is conservative. Most of the salvaged metals are gold, silver, and copper.

Aluminum Chosen For Rover Test Stand

Aluminum alloys, considered less susceptible to radiation damage, will be used for the structure of the Projec *Rover* nuclear-rocket test stand at the AEC's Nevada Tes Site. Aetron Division, Acrojet-General, will do the $7 million to $8 million architect-engineering job.

New Beryllium Ore Discovery

Commercial grade beryllium ore is being taken from the 150-ft. level of the old Redskin Mine, west of Pike's Peak. U.S. Beryllium Corp. is leasing the property on a 15%-royalty basis. The mine is on Colorado's Badger Flats, regarded as having the greatest potential for the ore in the U.S.

Cartridge Cases Obsolete?

The Army has developed a combustible cartridge case that eliminates the litter of spent cases in confined spaces such as tank turrets. The new case, 10 times lighter than its brass predecessor, minimizes the gases released from fired ammo and leaves no residue in the gun tube. Picatinny Arsenal, Armour Research Foundation, and the Ballistics Research labs at Aberdeen collaborated in the five-year development program.

ASW ENGINEERING

Reliability Problem in Hydrofoil Controls

BuShips is so concerned about the problem of reliability of hydrofoil controls that representatives of the agency are touring the nation to persuade industry to take a fresh look at the problem and generate new ideas for its solution.

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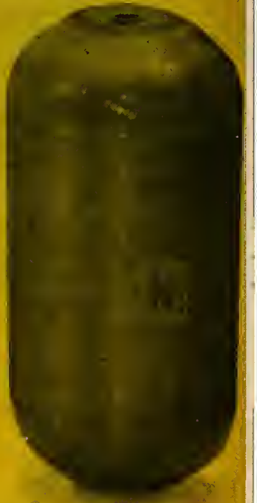
Now available in production quantities!

Spherical bottle for nitrogen storage in space satellite. 480 cu. in., 10 in. dia., 10 lbs. total weight. 3000 psi operating pressure, 5000 psi proof, 6667 psi min. burst after proof plus 25 operating cycles. Leakage guaranteed less than requirements of MIL-R-8573A.

Qualification test chamber designed to standard U.S. Navy specification. 18 in. diam., .041 wall thickness. 7.78 lbs. total weight including fittings and liner; 4.72 lbs. net weight of fiberglass-plastic. Tested to 650 psi burst, with hoop stress of 146,473 psi at burst. Actual strength-to-weight ratio of 2,035,000 in.

1300 cu. in. bottle for storage of high pressure nitrogen in ground-to-air missile. 8 ft. long, 5 in. dia., weight 32 lbs. including end fittings. 3000 psi operating pressure, 6000 psi proof, 9450 psi min. burst after proof and 30 operating cycles. Leakage guaranteed less than MIL-R-8573A.

80 cu. in. bottle for storage of concentrated sulphuric acid. 5 in. dia., weight 1 lb. including Teflon liner wound into structure. 150 psi operating pressure, 300 psi proof, 750 psi min. burst. Minimum life of 1000 operating cycles from 0 to 150 psi. Leakage guaranteed less than MIL-R-8573A.



2700 cu. in. bottle for nitrogen storage in space satellite. 2 ft. long, 13 in. dia., weight 31 lbs. including fittings. 3000 psi operating pressure, 3750 psi proof, 6000 psi min. burst after life of at least 400 operating cycles from 0 to 3000 psi. Leakage guaranteed less than MIL-R-8573A.

This is Hystran, Lamtex's new space-age material that is solving high pressure storage vessel is considered impossible or impractical with previously available materials such as aluminum, titanium! A fiberglass reinforced plastic material, Hystran is filament-wound on automatic ıs developed and built by Lamtex. The unretouched close-up photo shows the smooth finish cise control of filament angles and spacing, resulting in a perfectly uniform, predetermined tion of fiberglass and plastic, particularly when winding the calculated end shape. Equal control on each fiberglass filament is automatically maintained during winding, insuring progressive fiberglass failure under high stresses.

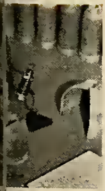
In addition to the superior strength, weight and physical properties of Hystran, Lamtex's ion-proved design and fabrication methods offer considerable savings in engineering time ling costs, plus a new degree of flexibility in the choice of sizes and shapes of pressure . Standard procedures and production facilities are now available at Lamtex to handle—on a ion basis, not prototype or experimental—filament winding of pressure vessels and other al shapes up to 7 ft. dia. and 30 ft. long.

COMPARE THESE SPECS!

MATERIAL	DENSITY lbs/cu. in.	TENSILE STRENGTH psi	STRENGTH / WEIGHT in. x 10^6
Aluminum	.097	80,000	.83
Titanium	.163	160,000	.98
Highly Heat Treated Steel	.283	240,000	.85
HYSTRAN	**.072**	**165,000***	**2.29**

*Biaxially stressed hoop tension

FOR COMPLETE DATA, SEND FOR BULLETIN 14D

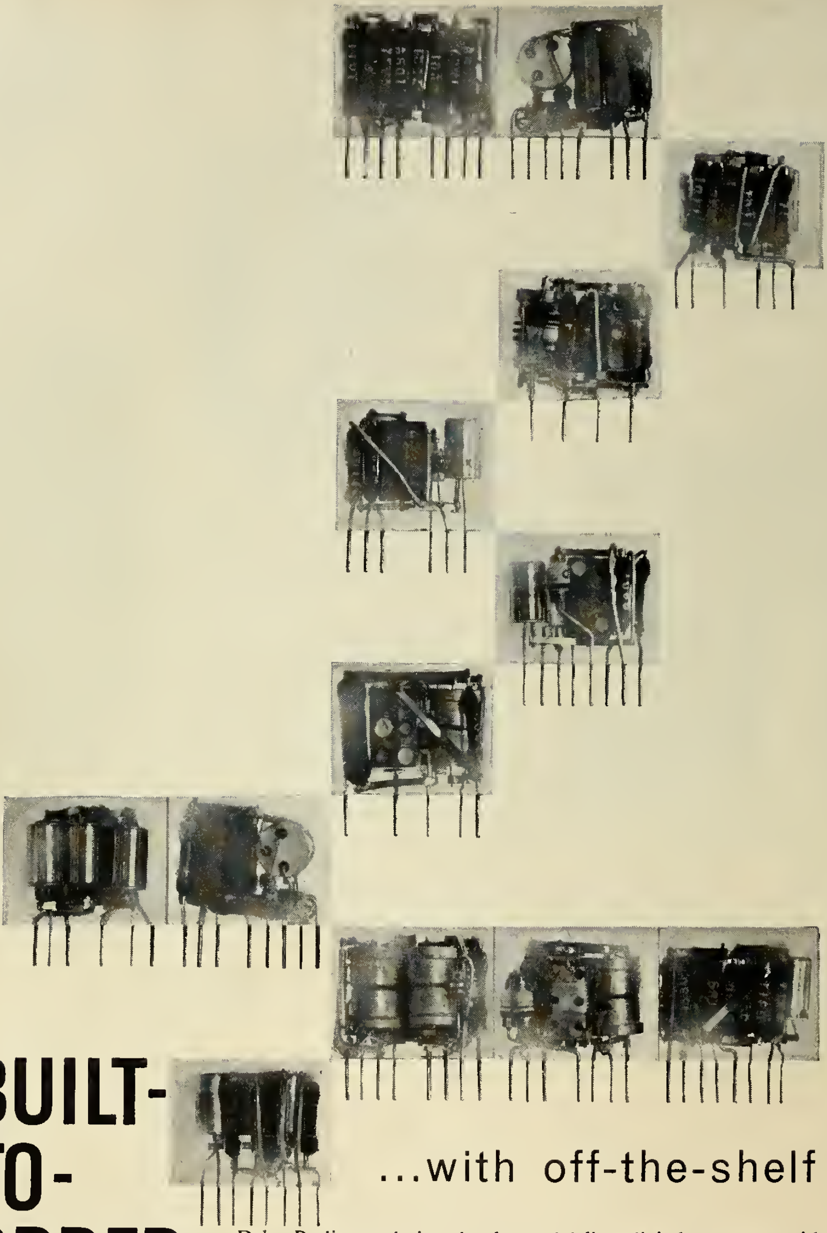


Advancing the State-Of-The-Art in Reinforced Plastics...

At Lamtex, it begins with R&D! The achievement of significant technological progress in the highly specialized, rapidly changing field of reinforced plastics depends largely on truly creative, "dig-down-deep" R&D. To obtain it, you must gather a staff of skilled specialists with outstanding records of past accomplishments and unlimited potential for future progress. Then give them the tools to work with, and the creative environment to work in—and you're well on your way toward advancing the state-of-the-art. This is what we've done and will continue to do.
Lamtex Industries, Inc., Motor Avenue, Farmingdale, L. I., N. Y.

LAMTEX

AN FILAMENT WINDING | CUSTOM MOLDING | FIBERGLASS-EPOXY TUBING | ROCKET MOTOR CASES & NOZZLES | RADOMES | MISSILE NOSE CONES | UNDERSEA VEHICLES



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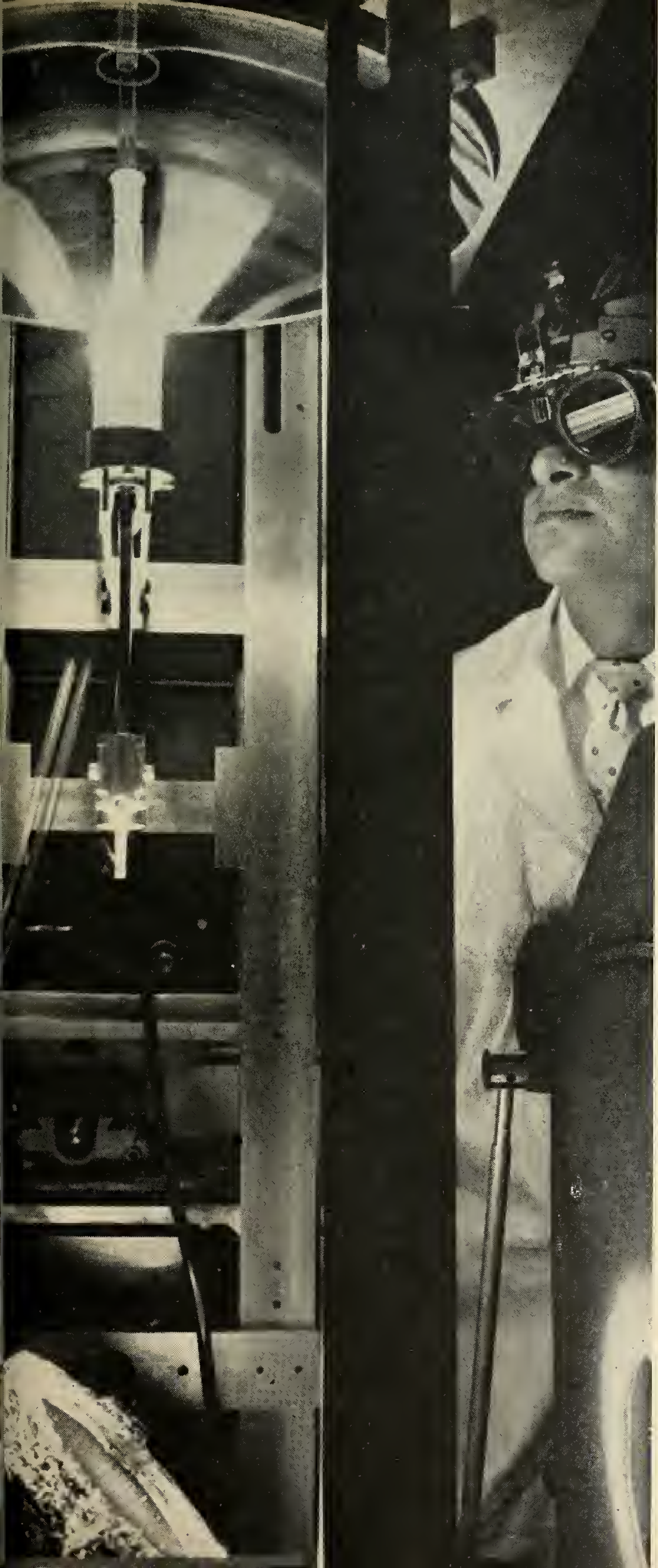


MISSILES AND ROCKETS

ADVANCED MATERIALS

SPECIAL REPORT

- MISSILE/SPACE MATERIALS Gap worsened during year: no breakthroughs; interesting developments, but few of lasting engineering value

- GLASS FILAMENT WINDING—a detailed account of how one company manufactures the hottest items in the rocket business today

- CERAMICS—a progress report describing the last frontier in high-temperature materials

- STEEL—Industry moves closer to the magic 300,000 psi motor case through intensive research and integrated testing procedures

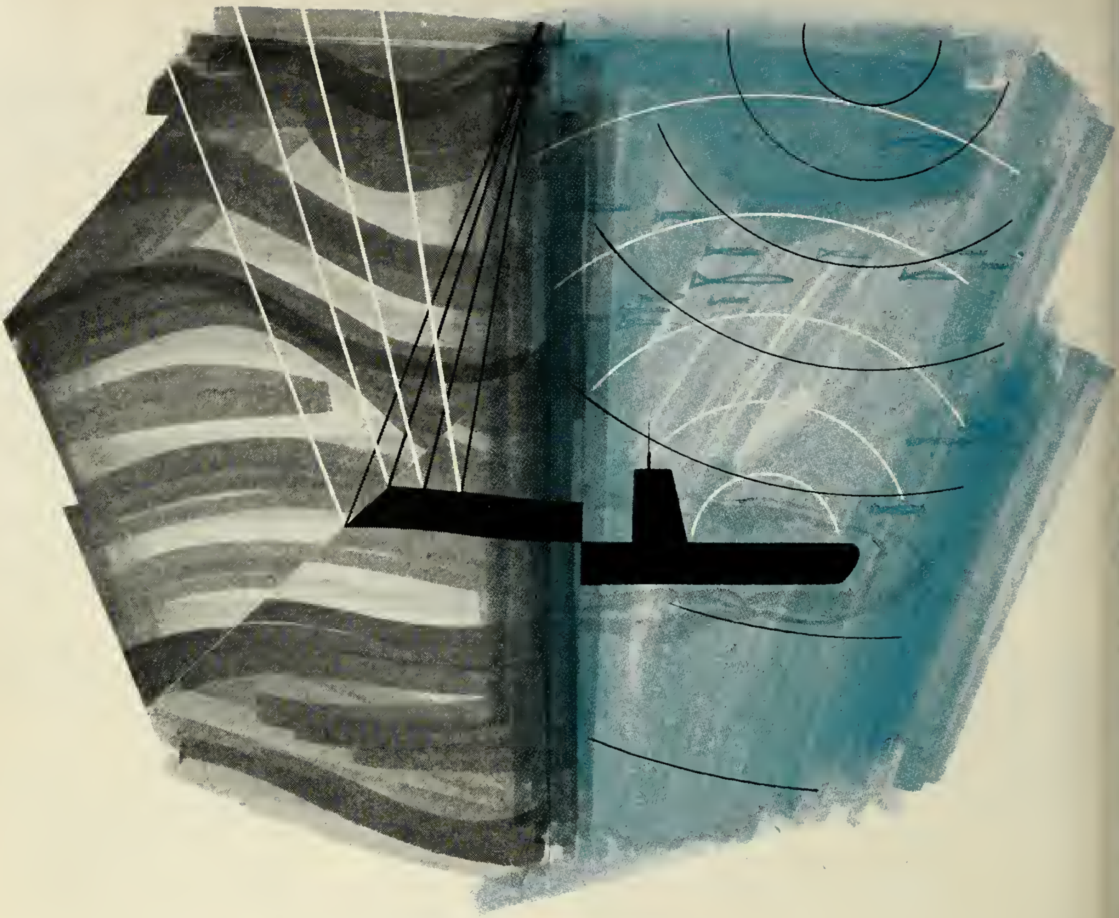
- RESEARCH—Specialized analytical techniques focus on fundamentals in the effort to understand materials and increase their usefulness

- SELECTIVE PLATING—Intricate missile parts saved from the scrap heap by a unique process of plating which eliminates the familiar immersion requirements

- DRAG DEVICES—An analysis of the materials available for re-entry decelerators and design problems

- MANNED VEHICLES—The stringent demands of space force designers into new and unfamiliar materials fields.

GROWING crystals in an arc-image furnace at Stanford Research Institute.



OIL AND SUBMARINES?

Yes—reflected "sound" detects them both!

For fifteen years Dresser Electronics has pioneered the development and manufacture of oil exploration instrumentation . . . seismic systems based on reflection techniques.

Now these same instrumentation techniques are being adapted to anti-submarine warfare. Dresser Electronics systems engineering is also at work in airborne telemetry . . . civil defense . . . process control . . . blast detection . . . mobile hospitals—projects throughout military, industrial and defense areas. *The unique approach of this systems-oriented company may solve your problem.*

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Materials Gap Widens

Few Significant Developments in Past Year

- ***Assessment of balance between technology and science leads to understanding of Materials Lag***
- ***Materials frequently lack complete engineering documentation necessary for classification***
- ***Disproportionate effort in solving single problems sacrifices rigorous, professional experiments***
- ***Establishment of a materials technology based on fundamental knowledge deemed necessary***

by Dr. George J. Mills

Manager, Materials Research Operations, Aeronutronic Division, Ford Motor Company, Newport Beach, Calif.

THERE HAS been no significant change in the status of engineering materials in the past year. We are still a long way from having an available stockpile of technology to cope with present and future problems.

The key to understanding the current "materials lag" is a determination of the important elements and their interaction in the research, development, production and engineering application cycle—the balance between science and technology.

• **Superficial progress**—Although a substantial number of interesting developments have occurred during the year, few so-called "major breakthroughs" of lasting engineering or scientific value have appeared. Still, some encouraging steps have been made.

In the ablation materials field, specific materials are now offered for engineering design, and others have passed the testing phase. Current rocket nozzle applications do not appear to pose insurmountable problems, thanks to the improved state of the art in graphites and coating methods. The demand for thermal insulation is being met with foamed ceramics, plastics and a variety of fibrous materials. Requirements of solid rocket cases are now comfortably satisfied, with the titanium alloy and filament-wound approaches proving advantageous in specific systems.

But aerospace technology, which obviously has not been standing still in the past year, seems to have reacted faster to the advancing sciences than materials technology. The pressure is on materials for impact energy absorption, rigid and inflatable space structures, long-time vacuum and radiation exposure, chemically erosive propellant exhausts and severe re-entry environments.

These requirements will be met—as they have been in the past, but with a considerable effort entailing large expense and tight scheduling. The effort will also call for commitment of research and engineering talent resources—and these are not inexhaustible.

Two serious problem areas are now clearly evident in our struggle for engineering materials to satisfy these unconventional requirements. The first concerns so-called "developmental research."

• **Too much too soon**—In technical literature, our laboratory shelves are being deluged with a variety of curious shapes, compositions, formulations, composite configurations and test coupons representing empirical processing evaluations.

In the past, some of these "materials" served a useful purpose, since many preceded the development of a useful functioning item.

Frequently, however, these materials lack complete engineering documentation or even the most meager information for classification into potentially useful fields of application. Duplication and subsequent repetition of these efforts on related problems is a common occurrence.

Too often these "technical breakthroughs" are being offered as proprietary items with the claim that they solve the variety of problems that have been plaguing us. The common attitude of "try it out and see if it works" is an admission of ignorance in the understanding what is being offered—because the fundamental nature or behavior of the material has not been established.

The point here is that considerable technology has been generated and is available. But it is ill-defined and scattered throughout our laboratories. It is of pertinent value only to the materials specialists working on the particular developmental problem.

This reveals an inherent and serious weakness in our approach to the materials technology field: we are devoting a disproportionate effort to solving single problems—at the sacrifice of rigorous, professional experiment.

Competent engineering and scientific personnel are being encouraged by this approach to devote an unreasonable amount of time to promotion of pseudo-scientific discoveries incompletely documented with basic facts.

This introduces the second problem area—the adequacy of our research efforts in providing the sound principles.

More serious thought and action should be devoted to establishing integrated basic-applied research programs in various materials areas. There should be prime emphasis on interaction with specific disciplines. Long-term and more lasting values are to be derived from broader understanding of the origin of materials phenomena. Their characteristics are thereby more readily amenable to direct control, and their behavior can then be knowledgeably predicted.

Better understanding of the electrical and mechanical properties of matter in the solid state, and the synthesis of new materials will always

(Continued on page 54)

Filament Winding Stretches Productio

- ***Researchers move closer to ultimate glass fiber strength in manufacturing structures***
- ***Uniform loading and resin impregnation of fibers is critical to satisfactory final product***
- ***Resin systems with elongation characteristics compatible to fiber are increasing in importance***
- ***Goodrich winding technique leads to optimum pressure vessel reproducibility.***

by G. A. Zimmerman
Mgr., New Products
and
C. P. Krupp
Mgr., New Products Development
Aviation Products Division
B. F. Goodrich Co.

RESEARCH, DEVELOPMENT and actual manufacture of many rocke and missile components on a production basis has shown that glass fibe filament winding can often yield bette and more economical results than th techniques it replaces—not just i parameters of direct cost, but in time weight, strength, durability, reproducibility, and reliability.

The basic design approach at B. F Goodrich has developed as a result o thorough investigation of the conditions affecting overall efficiency of a wound product. These studies hav shown that to take full advantage o the physical properties of filament-wound materials and obtain optimu structural efficiency, certain condition must be achieved.

• **Fiber tension**—Uniform loading and impregnating of fibers with resi is essential. This is done through application of direct tension. Prior to winding, enough tension must be applied to straighten out the fibers in the yar and permit each fiber to be impregnated and encapsulated with resin.

RIGHT: *Circumferential plies and skirt attachment shoulders are wound on a 54-in.-diameter rocket chamber.*

FAR RIGHT: *Longitudinal plies of glass fiber filaments, impregnated with resin, are applied by this rotary-type winding machine.*

ollar And Cuts Time

During winding, sufficient uniform tension must be applied on all fibers to obtain uniform density in the wound section. The tension serves to flatten the yarn and squeeze excess resin from within and between the fibers to provide a uniformly loaded material.

Fibers in direct tension are necessary for uniform loading; it is important that the method of winding be such that the fibers are always parallel to the forces to be applied and do not produce shear forces in the resin laminate by shifting under load.

Balanced construction in winding patterns is dictated by the internal chamber pressure requirements. The winding pattern or number of individual yarns required should be in relationship according to the basic pressure vessels formulas for thin-wall vessels, in order to restrain longitudinal and circumferential forces.

Circumferential Hoop Stress $\frac{D \times P}{2T}$

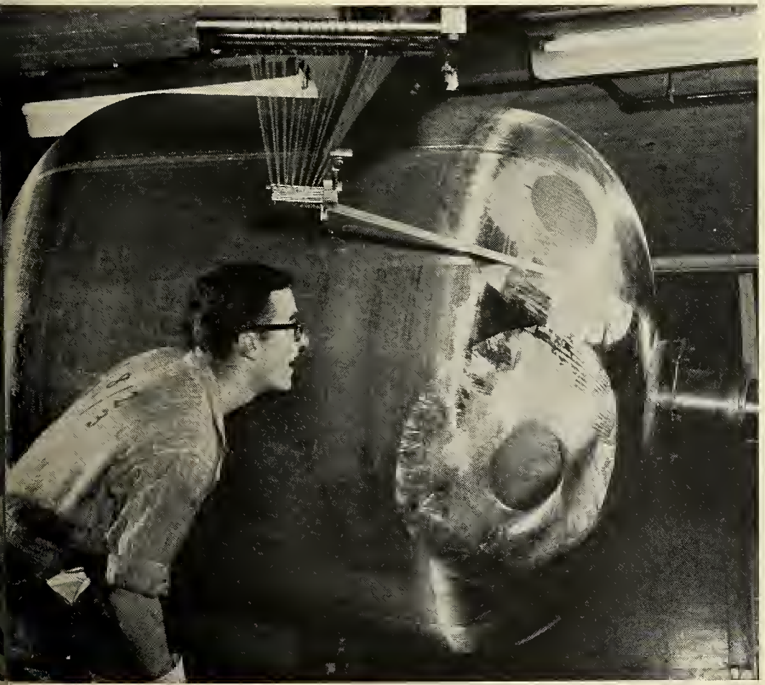
Longitudinal Stress $\frac{D \times P}{4T}$

Minimum bridging of winding patterns is vital if we are to achieve the ultimate in mass efficiency. If the winding pattern produces a cross-over condition (or herringbone effect) in single ply coverage, resin pockets will develop at cross-over points.

Under optimum conditions all yarns, in the longitudinal direction, will lie in a parallel, side-by-side attitude so that minimum thickness will be obtained in every ply. This condition cannot be achieved over the end domes; consequently, there is a compromise.

• **Closure technique**—Minimum thickness variation over elliptical ends can be obtained by winding with a multiplicity of yarns laid side by side, forming a tape that is as wide as practical. Each subsequent wind should be carefully indexed the width of the tape. As the chamber size increases, the number of ends of yarns is increased.

As the number of these ends increases, the importance of tensioning control on each yarn end increases.



Absolute control of winding patterns must be exercised to minimize strength variations from unit to unit, and to assure maximum case reliability. It is essential that winding techniques be so controlled that each case contain the exact number of winds required by the design calculations.

The B.F.G. winding technique is based on "individual thread count," which is probably the most practical method of insuring uniformity and product reproducibility.

Accurately controlled resin content, or resin-to-glass ratio, is the most critical control variable in filament winding. Factors involved here include resin pickup during impregnation, viscosity of the resin bath, tension during winding, winding pattern, degree of "B" staging prior to cure, and the rate of heat transfer during cure.

These variables are all individually controllable to a degree; it is control of their combinations that requires the major effort to establish precise tolerances.

Existing resin content of maximum density is vitally important in determining mass stress levels in a chamber. It also directly affects the mechanical properties of the plastic laminate.

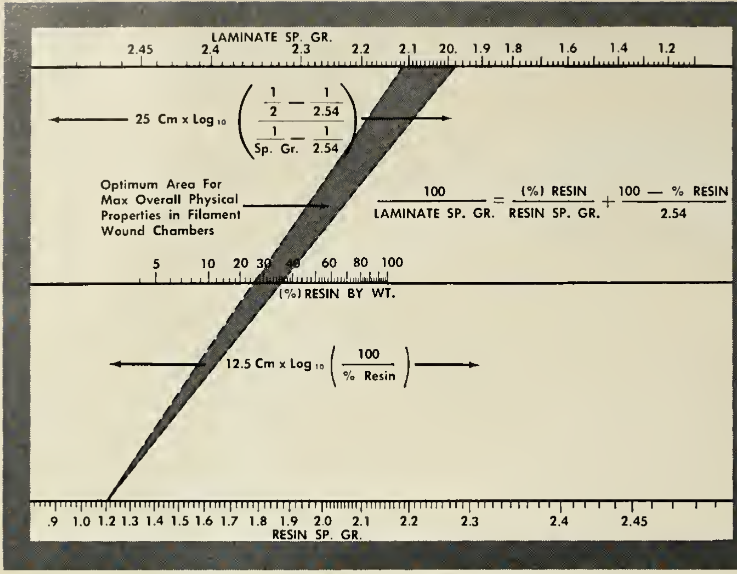
To assure maximum density, effective control must be exercised over the winding procedures, especially the tension during winding, the resin viscosity, and the curing characteristics of the resin system.

• **Resin problems**—Maximum glass-to-resin bond brings maximum mechanical strength of a plastic laminate. Mechanical strength is affected both by the finish or coupling agent and by the type of resin system used on the glass yarn. If to provide maximum surface reactivity, these coupling agents must be effectively applied during manufacturing of the glass fiber. When these finishes are subsequently applied on heat-cleaned glass, the resulting physical properties drop substantially.

The commercially available Silane types, such as 801 or 890, are the best in overall properties and are used extensively in filament winding work.

Resin systems with elongation characteristics compatible with the glass fiber are becoming increasingly important as the design strength level of a filament wound chamber goes beyond the 70,000 psi figure. In this respect, many commercially available epoxy resins are marginal when maximum mechanical and heat distortion properties are to be maintained.

The preceding analysis of conditions that must be achieved logically led to development of the B.F.G. Biaxial Method of filament winding.



Nomograph for determining the theoretical specific gravity of glass fiber reinforced plastic laminates

This involves the winding of a group of individually tensioned glass fibers carried out in two separate operations.

First, longitudinal plies are wound on a rotary-type winding machine. The mandrel is covered with a rubber insulation liner on which the plies are wound. The axis of the mandrel or form is inclined so that the top of one port or pole fitting, and the underside of the opposite end pole fitting, are in a parallel plane. The container itself is rotated around an axis perpendicular to this plane, and intersects the exact center of the container. The winding pattern does not develop a helical angle to the winds. It consists of winds in a straight plane, from pole to pole, that are indexed at each pole a sufficient amount to advance the tape one tape width at the outer periphery of the container.

This produces a completely unidirectional cord pattern in the cylindrical section of the container. With one revolution of the container, two actual plies are generated—each ply opposing the other in angle.

After the container makes one complete revolution, thus producing two complete opposing plies, a single circumferential wind is put on to give maximum density to the longitudinal plies already applied. Subsequent longitudinal plies are put on according to the design strength requirements, with a circumferential ply interspersed on every two plies.

The second step in the Biaxial Method is circumferential winding. After completion of the longitudinal winds, the container is moved to another machine designed specifically for this purpose.

In this machine, 112 ends of glass yarn are impregnated with resin and wound under demand conditions in a sufficient number of plies to meet design requirements.

Shoulder areas must be reinforced, because of the low value of interlaminar shear of filament-wound cases. Reinforcing with fiberglass cloth impregnated with epoxy resin provides a strong shoulder area capable of withstanding stresses and loads. Where port reinforcements are required, they are introduced between longitudinal winds. This gives extra strong support and makes a durable port opening. After curing, the port openings are machined to exact size.

• **Method's potential**—One of the outstanding advantages of filament winding is that it permits building in a variety of physical properties through proper selection of raw materials. Selection from several basic glasses, such as the regular "E" glass, and a newer glass with a very high modulus of elasticity, can help establish desired properties of the finished wound product.

Studies of the properties of commercially available individual "E" glass filaments show remarkable consistency in the nascent state.

Initially, just about everyone concerned with filament winding turned to "E" glass because of its availability. The fiber was first used in electrical insulation applications and then in textiles. In addition, its good handling qualities are desirable in winding techniques. Structural characteristics in clude:

Ult. Tensile Strength	230,000 ps
Flexural Strength	280,000 ps
Specific Weight	0.078 lb/cu. in
Modulus	7.5 x 10^6 ps
Elongation	2–3%
Compressive Strength	70,000 ps

These individual filaments, wher coated with a moisture-resistant coupling agent and typical epoxy resin, will develop a maximum mass stress level of approximately 250,000 when used in the most optimum type of unidirectional laminate.

The design requirements of a structure determine the resin system used to impregnate the glass fibers for filament winding. This selection is the most critical, yet the most versatile, factor in a filament-wound structures. Many resins are available, each noted for particular physical properties in the finished product. However, so many varieties of each resin are available that an almost infinite choice of properties can be achieved.

Complete quality control is an absolute must in every phase of filament winding—from selection of raw materials to shipping of finished product. Quality must be built in, not inspected in, and consequently B.F.G. maintains continuous surveillance by both automated controls and skilled engineers. This is the only way that near 100% reliability can be assured.

In the fabrication process alone there are as many as 60 check points, with a number of quality control activities to be carried out at each point.

Previous work in the aviation and missile fields has strongly emphasized this need. As a result, B.F.G.'s Operational Research Group and Computer Scientific Group have coordinated their reliability studies. The "state of the art" in reliability is under constant study, and necessary procedural changes and system upgradings are made whenever and however practical.

Rocket motor cases represent only one of the many successful applications of the Biaxial Method of glass fiber filament winding. The manufacturing flexibility of this technique enables the creation of spherical, hemispherical, conical, open or closed and cylindrical vessels, irregular shapes and flat surfaces.

Products can be produced in an extensive variety of shapes. Heat, strength and weight properties can be built in as desired through proper selection of materials—a factor that assures the ultimate in air-borne thrust chambers, rocket chambers, cones and pressure vessels. #

WESTINGHOUSE AEROSPACE PROPOSAL:

STRUCTURAL MATERIALS DEVELOPMENT
FROM SPACE COLD TO RE-ENTRY HOT

FORMING MOLYBDENUM CUPS: PROOF OF METALS COMPETENCE

Here's a typical example of exacting Westinghouse materials competence in the aerospace age. Note: Westinghouse integrated a number of advanced techniques to accomplish this metallurgical feat.

At the Westinghouse Metals Plant in Blairsville, Pennsylvania, this is one of many tests performed to prove the forming and fabricating quality of the product. Metallurgists deep-draw cups in pure molybdenum at room temperature. Such an operation was impossible just a few short years ago.

Let's just briefly review the development of workable molybdenum sheets.

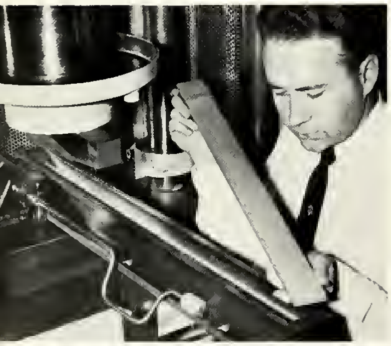
First, basic metallurgical research developed the vacuum-melting process for obtaining pure metal.

Then, Westinghouse scientists developed the cyclic continuous compaction technique for compacting pure molybdenum powder into 1/4″ x 2″ x 30″ bars. These bars were sintered to 95% of their theoretical density. The sintered bars were then hot-rolled into .060″ strip.

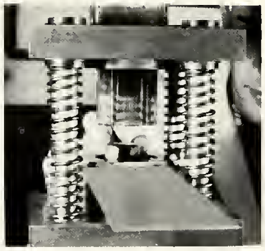
From the cryogenics laboratories came the strength and ductility data of extreme low-temperature tensile testing of molybdenum. These low-temperature studies revealed why molybdenum was a brittle, unworkable metal. They provided the basic leads for developing an easily workable metal for high-temperature applications in the 3100°F range.

Many other calorobic and cryogenic materials including metals, alloys, plastics and ceramics—as well as associated fabricating techniques—are on hand at Westinghouse. The following pages describe some of the immediately helpful areas.

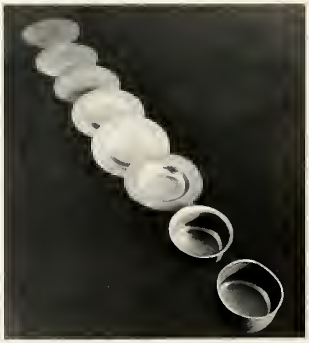
These advances in materials development and fabrication may provide you or your colleagues with a long-sought solution to long-life space structures.



Laboratory set-up for cyclic continuous compaction of powdered metals.



Removing molybdenum cup punched at room temperature.



Cup-forming sequence as shown by interrupted samples.

Typical molybdenum cup showing excellent room temperature formability.

ONE-STOP SERVICE FOR COMPLEX METALS

Name your materials development problem. The Westinghouse Metals Plant at Blairsville, Pa. has an "everything under one roof" approach that simplifies and speeds the mastery of metals.

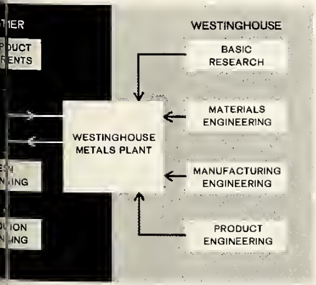
The Metals Plant is a flexibly knit group of skilled manpower, brainpower, and fabricating facilities designed to develop new metallurgical materials and many new processes. Emphasis is on wrought alloys and cast-metal products, as well as rolled sheet and plate.

This Westinghouse plant proves new ideas and designs in pilot plant operations. And, after completing experimental and development work, they can process the actual materials and manufacture end-products at this fully integrated plant.

Complete metalworking facilities include vacuum- and atmosphere-induction furnaces, vacuum-arc melting furnaces, bell-type furnaces, a skull melting furnace and special quenching facilities. Other metalworking facilities include heavy equipment for metal conditioning, forging, pressing and rolling. For the precision parts or intricate shapes, facilities for skull-melting, shell-molding, lost-wax investment casting and sintered metal processes are available.

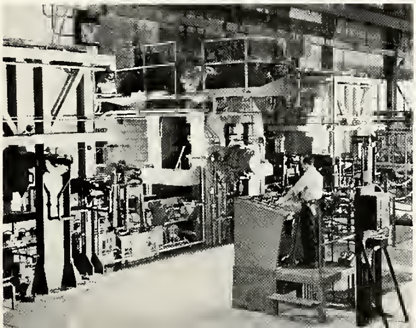
Services offered include materials development, metallurgical engineering, chemical and physical analysis, pilot plant studies, and metal production. Because we integrate and centralize developmental operations and manufacturing under one roof, new data and new ideas are quickly turned into practical application.

Photos below show representative sampling of the multi-purpose facilities available at the modern Westinghouse Metals Plant. We may already have developed the materials or processes to meet your structural design demands.

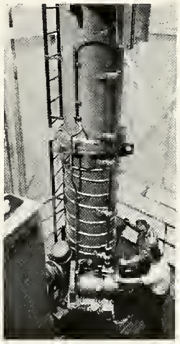


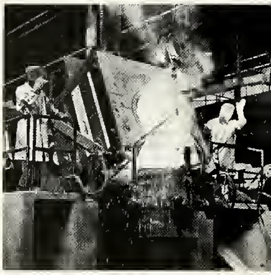
All these integrated Westinghouse resources aid your metals development.

Hot mill main stand is designed to roll slab down from a maximum 8-inch thickness to .090 inches.



This cold-hearth furnace melts high-purity metals without contamination to meet today's demand for refractory metals.





5,000-lb. heat of special alloys is produced from this unique melting furnace.

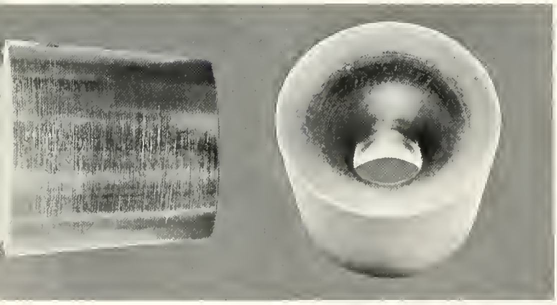
NEW METALS, NEW ALLOYS FOR AEROSPACE VEHICLES

Wherever metals men gather, talk inevitably centers around the search for an ultimate material. So it is at Westinghouse. We're investing heavily in space-age materials that defy the destructive elements of corrosion, fatigue, creep rupture, and erosion.

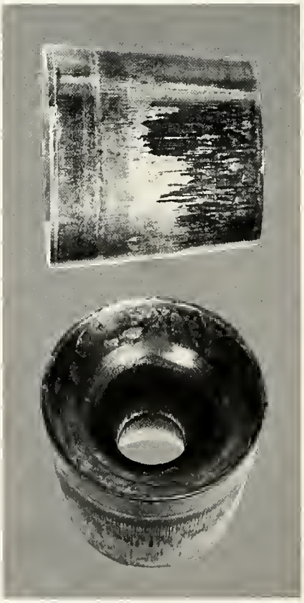
The Westinghouse Metals Plant has logged an impressive inventory of metallurgical knowledge about high melting-point metals and alloys. This knowledge has helped improve actual performance of many products. Refractory metals such as columbium, molybdenum, tantalum, and tungsten have been investigated in great detail.

Alloys come in for their fair share of data accumulation and evaluation. Large families of magnetic alloys such as Hipernom and Hipernik®, refractory alloys such as Nicrotung and Discaloy®, and special alloys such as Nivco and Kovar® have found practical application in many aerospace projects.

We would welcome an opportunity to discuss your metals development requirements.



Atlantic Research Corporation rocket nozzle test throat insert machined from arc cast ingot.



A high temperature and a high deformation rate was used to make this pure tungsten nozzle on the Dynapak.

This Model 1200 Dynapak is capable of delivering 160,000 ft. lbs. of energy.

...AND THE PROCESSES THAT MAKE THEM PRACTICAL

As new metals are born, techniques and equipment must keep pace, too. At the Westinghouse Metals Plant, development of new metals and processes saves customers heavy capital investment. A strict adherence to design requirements assures customers close control of their product.

To prove the practicality of much of our metals knowledge, Westinghouse has developed a number of metallurgical processes. Out of these processes emerges some highly favorable fabrication data.

Item: techniques for vacuum-arc melting pure tantalum and tantalum-tungsten alloys, molybdenum and molybdenum-tungsten alloys, niobium and its alloys, and pure tungsten.

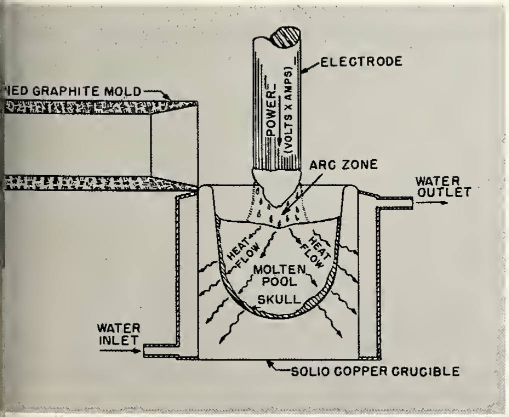
Item: techniques for producing "cast to shape" parts by the "skull" casting method. Parts weighing 45 pounds have been cast of niobium and its alloys, and pure tungsten.

Item: protective-atmosphere forging of easy-to-oxidize metals to permit hot working at 3500°F.

Item: techniques for forging tungsten shapes. Pure tungsten bars are forged directly from an arc-cast ingot using an inert atmosphere forging chamber to protect the material from oxidation at temperatures above its recrystallization temperature.

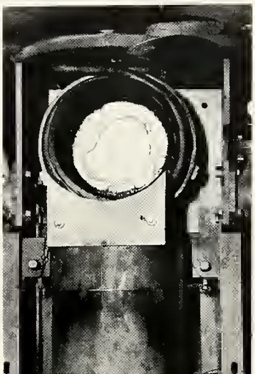
Item: powder metallurgy techniques for producing high-temperature rocket-nozzle inserts from such refractory metals as molybdenum and tungsten.

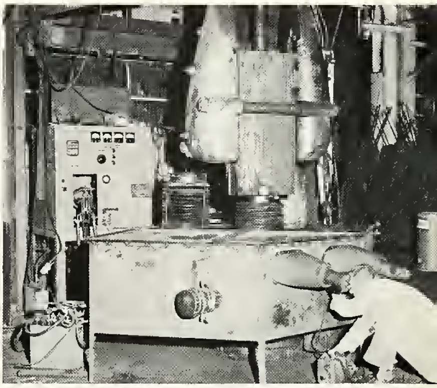
So we have the means of developing materials to withstand both high and low temperatures. Space cold or re-entry hot. And our object? Why, contracts, of course. For materials development and component production. Interested parties should refer to coupon on last page of this advertisement.



Schematic cutaway shows position of internal components of skull furnace while forming molten pool.

Interior of skull furnace after pouring.





This controlled atmosphere chamber permits the true "hot working" of refractory metals.

CERAMIC MATERIALS: ANY SIZE, ANY SHAPE, AT BREAK-THROUGH MELTING POINTS

Westinghouse's Ceramic Engineering Department has developed an entire new family of materials for space-age applications. Westinghouse scientists are already probing the areas of high thermal shock for combinations of such calorobic materials as:

		Melting Point °F
Silica	SiO_2	3100
Zircon	$ZrSiO_4$	4100
Zirconia	ZrO_2	4900
Boron Nitride	BN	5430
Zirconium Boride	ZrB_2	5540
Zirconium Carbide	ZrC	6400

Performance characteristics such as high melting point, good thermal insulation, heat and erosion resistance, capacity to withstand high temperature gradient and relative immunity to combustion products, suggest the following applications for these materials:

leading edges of hypersonic craft · fuselage—outer wall panel · nose cones · rocket nozzles · radar windows · thermal insulators · wearing parts (bearings, etc.) in high temperature areas · jet vane control · flame holders · ramjets

Current and past development projects in the Westinghouse Ceramic Engineering Dept. include: ferrites · ceramic permanent-magnet materials · ceramic insulating and protective coatings · ceramic-to-metal seals · nuclear fuels · infrared transmissive glasses · thermistors · voltage limiting resistors · refractory structural materials (i.e. cermets and pure oxides)

Westinghouse formed these ceramic rocket nozzles for test firing in a MERM (materials evaluation rocket motor).

The ceramic material in this 10" O.D., 11" long rocket nozzle was designed to operate in the exhaust of a high energy aluminized fuel solid propellant rocket.

WESTINGHOUSE PLASTICS PROTECT VITAL PAYLOADS

Example: Tape-wound laminates from Westinghouse's Micarta Division at Hampton, S.C., solve the problem of light, strong, ablative heat shields for re-entry. In plastics, as well as metals and ceramics, Westinghouse can provide development and manufacturing service for both calorobic and cryogenic applications.

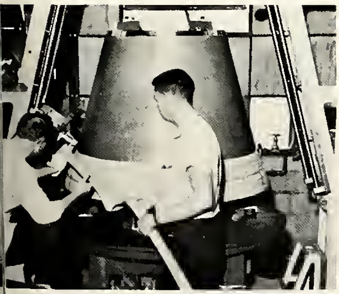
Shown below is an example of how Westinghouse materials development has helped solve the nose cone re-entry problem.

Laminated plastic tapes are spiral wound on nose cones to form the heat shield. The spiral tape system is extremely versatile. Fabric thickness can be increased from inside edge to outside edge, to give a tapered cross section.

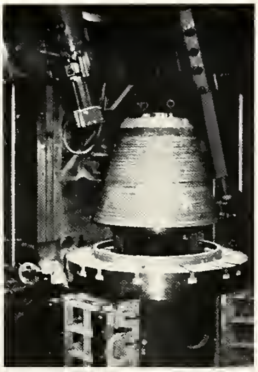
Fundamental component of laminated-molded plastic heat shields for re-entry bodies is the resinous binder. Westinghouse's Micarta Division's 7H186 is a specially-developed phenolic resin which exhibits extreme thermal stability. This resin has been used in conjunction with glass, quartz and leached glass reinforcements to produce oriented laminated-molded heat shields.

The nose cone shown below will ablate at a controlled rate.

The Micarta Division of Westinghouse is developing new materials for rocket motor housings, exhaust jets, satellite components, aero-dynamic foils, air frame components and numerous other space-age applications. For more information, please use the handy coupon on the last page of this advertisement.



Spiral winding the laminated plastic tape on Flare Section.



Machining the wrapped section.

The completed nose cone section.

This plastic compressor housing incorporated into a jet engine showed remarkable performance under actual operating conditions. Weighs less than conventional aluminum or magnesium alloy units. Outperforms them too. Pressure molded of glass-cloth polyester, the housing also costs less, machines more readily, and resists corrosion better than its metal counterparts.

Westinghouse Aerospace Proposal

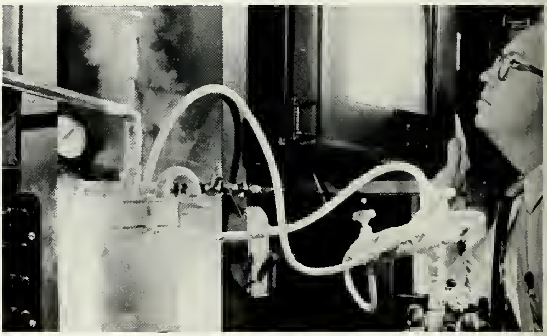
CRYOGENICS INSIGHT... MATERIALS TESTING AT —452°F

Westinghouse is interested in the low-temperature properties of structural materials. Our behavior studies range from fundamental research ... through applied research and development . . . to collection of actual engineering data. Results of these investigations have been applied to normal—as well as high-temperature problems. We'd like to share some of these findings with you.

Although it is not too generally recognized, low-temperature mechanical testing is quite useful in development of new metals and alloys for many applications. In addition to malleable molybdenum, Westinghouse has advanced some of the rare-earth metals to promising potential with cryogenic studies.

In working with niobium, for example, low-temperature testing showed that small variations in gaseous impurities could cause marked differences in flow and fracture characteristics. Vacuum annealing treatment of test specimens helped identify the responsible impurities, providing invaluable data for developing this metal and its alloys. Low-temperature mechanical testing has proved to be a key tool in the study of strength of materials for exacting uses.

These facilities are available on a developmental contract basis.



This low-temperature testing apparatus was built by Westinghouse for strength and ductility studies of metals. The device attains temperatures as low as —452°F (4.2K) through use of liquid helium.

J1 92509

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Westinghouse

Westinghouse Electric Corporation
P. O. Box 868, Pittsburgh 30, Pennsylvania

Yes, I'm interested in your Aerospace Materials Capability.

☐ Please have Westinghouse Sales Engineer stop by to discuss my component requirements.

My major interest is in ☐ Calorobics ☐ Cryogenics.

Please send me data for these applications:

REFRACTORY METALS AND ALLOYS FOR:	TEMPERATURE RANGE	OPERATING ENVIRONMENT	OPERATING TIME
☐ Rocket Motor Components			
☐ Skin Materials for Mach 3 and Higher Speed Vehicles			
☐ Space Vehicle Components			
☐ Nuclear Power			
☐ Thermoelectric Devices			
☐ Thermionic Conversion			
☐ Magnetohydrodynamics			
☐ Closed-Cycle Gas Turbines			
☐ Semi-Conductor Devices			
☐ Electronic Components			
☐ Magneto-Mechanical Devices			

REINFORCED PLASTICS	TEMPERATURE RANGE	OPERATING ENVIRONMENT	OPERATING TIME
☐ Rocket Nozzles			
☐ Ablative Heat Shields			
☐ Housing for Jet Engine Compressors			
☐ Aerodynamic Foils			
☐ Air Frame Components			
CERAMICS			
☐ Leading Edges of Hypersonic Craft			
☐ Fuselage-Outer Wall Panel			
☐ Rocket Nozzles			
☐ Radar Windows			
☐ Thermal Insulators			
☐ Wearing Parts in High Temp. Areas			
☐ Jet Vane Control			
☐ Flame Holders			
☐ Ramjets			

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Ceramics Pose Greatest Challenge

- ***Huge potential blocked by brittle characteristics***
- ***Reliance on empirical preparation methods***
- ***Higher purity one tack in current investigations***

by Frank Halden
Senior Ceramic Technologist
Stanford Research Institute

PERHAPS NO CLASS of materials has greater potential for meeting present and future missile needs than ceramics—the oxides with their low density, great stability and strength at elevated temperatures, the carbides with their extreme melting temperatures and hardness, and graphite with its excellent thermal shock resistance.

Yet, ceramics have been the least utilized and in some respects the most disappointing. Why? What must be done and what is being done to take advantage of these materials?

There are two major limiting factors in working with ceramics—their brittleness and the difficulty in controlling their fabrication processes.

As a class, ceramics are perhaps the most difficult materials to study and utilize. Their stability and refractory characteristics limit purification possibilities. Since they are primarily ionic compounds, their ductility is considerably less than that obtained in metals. Stoichiometries often are not sharply defined but may vary with considerable changes in properties.

Problems such as these have forced a heavy reliance on empirical procedures for preparation and handling. Only recently, with the development of modern heating techniques and chemical tools, have we been able to examine these materials in some detail.

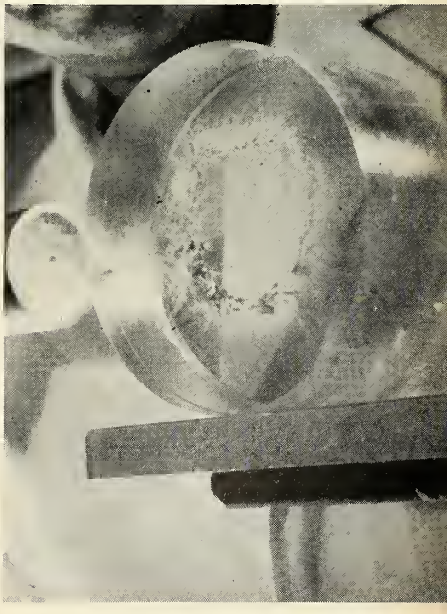
To decrease brittleness we must obtain much higher purities, gain an understanding of failure mechanisms, and control grain size, porosity, and surface condition. Combinations of ceramics with metals and plastics are being studied in hopes of taking advantage of the desirable properties without being handicapped by their limitations.

To improve ceramic fabrication, industry must explore entirely new techniques and gain a better understanding of operable mechanisms. We must develop testing procedures suited to this type of materials, not just borrow available techniques which have been developed for metals.

• **A bird in hand**—It is probably fairly safe to say that no new wonder materials will be discovered which will combine extreme melting point, high stability, high strength at elevated temperatures, ductility, and good thermal shock resistance. Rather, the greatest progress probably will come as we learn to handle and control the materials now available. This will require at least as much scientific effort as has been devoted to metals—in view of the additional problems, probably considerably more.

Stanford Research Institute, together with a number of other research facilities, is attempting to provide some of this advancement. Programs in progress deal with development of improved coating techniques for ceramics on metal and metals on ceramics, growth and study of single crystals of refractory compounds, development of improved testing techniques, examination of residual stress distributions, investigation of the influence of surfaces on physical properties, and the study of the influence of deviations in stoichiometry on physical properties.

From such bits and pieces will come the clues leading to development of superior materials for missiles and space craft. As research continues, we can expect an increasing rate of improvement in the properties of high-temperature materials. ⁑



Radiation Effects

SHORT PULSES of Gamma radiation equal to that of an atomic explosion are produced by a linear accelerator at Hughes Aircraft. Nozzle appears on the left of the lucite target.

300,000 psi Case Yield Strength Ma

- *Prediction based on experimental results and a realization that current metals are being used at a fraction of potential*
- *High-yield steel must start with maker's recognition and control of new factors*
- *Steel will remain the dominant materia until filament winding is perfected*
- *Need still exists for correlation betwee various specimen tests and the performance of the pressure vessels*

THE ENTIRE SOLID-PROPELLANT missile industry is working to solve the many problems associated with materials for rocket motors—spurred by the need for reliability and increased system efficiency.

This efficiency drive is channeled either toward raising propellant specific impulse or increasing the mass ratio.

The terminal velocity of the vehicle is a function of these two values: it varies directly with specific impulse and exponentially with mass ratio. Hence, important increases in terminal velocity, or system efficiency, can result from relatively small decreases in weight of inert parts.

The search for lightweight components has led to general use of ultra-high-strength steel for rocket motor cases. Glass filament-wrapped cases may eventually displace steel for many rocket motor applications, but until this material is developed further and tested in use, steel will remain dominant.

Raising usable strength level of steel with high reliability is now very important to industry. Steel will remain the primary material for many applications where glass filament will not meet design and operational requirements. Steels, when produced and fabricated by current state-of-the-art techniques, appear to be limited to a useful strength level of about 240,000 psi yield strength. Above this point, brittle behavior becomes more likely and burst strength of pressure vessels becomes erratic and falls off rapidly.

• **Ultimate in sight**—Industry effort has been applied toward pushing this limit upward. Experimental studies at Solar give some promise that the much-sought-after goal of 300,000 psi yield strength may be possible and practical.

It is well known that iron whiskers have an ultimate tensile strength of over 1,000,000 psi. The actual atomic force holding the material together is therefore many times greater than anything realized in practice today. Today's materials are used at a small percentage of their theoretical capability: a number of small pressure vessels have been burst tested at Solar, exhibiting burst strengths up to 361,000 psi. Other investigators have experienced similar results, indicating that this performance level is definitely within the capabilities of the material.

Therefore, the problem is one of identifying and controlling those variables which enable one vessel to sustain over 300,000 psi stress while another apparently identical vessel may burst at half that value.

The test methods used in evaluating materials have an important influence on results and conclusions. Tensile properties, as determined in a uniaxial test, are not sufficient as criteria of a material's usefulness in a motor case. Brittle behavior, or lack of resistance to crack propagation under the system of stresses imposed in a pressure vessel, results in erratic burst strengths.

Various tests have been devised to indicate the tendency of a material toward brittle failure, but there is still need for correlation between these tests and the performance of pressure vessels made of the material. Solar has relied largely on the use of small pressure bottles as being the most reliable test of a material. These tests are supplemented by metallography, hardness, X-ray diffraction and X-ray fluorescent analysis.

Fabrication and joining processes are under investigation to identify and control brittle behavior variables.

Fundamental metallurgical research includes studies on the mechanism o brittle fracture; influence of chemistr on weldability; influence of such factor as grain size, segregates, decarburization and inclusions on notch sensitivity influence of ausforming, strain aging and special heat treatments on mechanical properties; and test methods fo evaluating materials.

Several of the newer treatment depend on deformations at some tim during the processing cycle for producing ultra-high strength. Ausforming an strain aging both have the effect of reducing the spread between ultimate an yield strength, pushing the yiel strength up to well above 300,000 psi

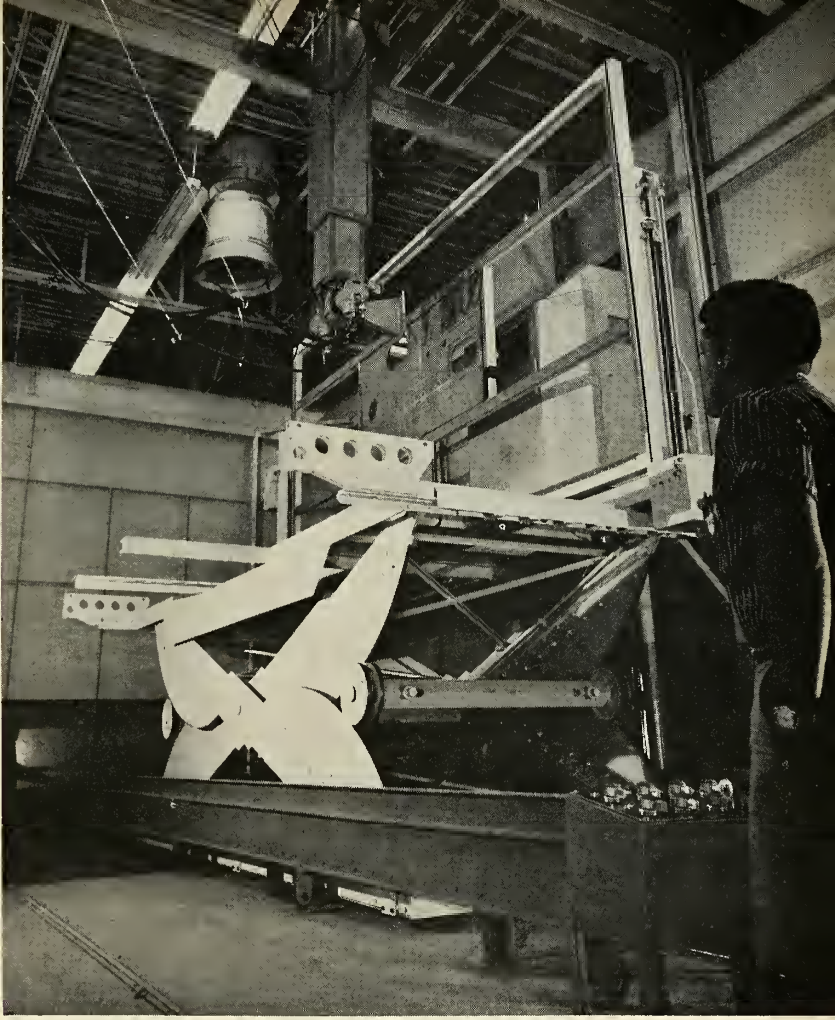
Surface decarburization already ha been recognized broadly as one of the steps necessary to reach the 300,000 ps yield strength goal. It has the effect o softening the surface layers and reducing notch sensitivity with only mino loss of total section strength. Solar is evaluating various decarburized conditions to determine the controlling factors in the process.

• **Manufacturing methods**—If the ductile-brittle boundary is the first impediment in the way of the 300,000 psi case, defects introduced by the steel manufacturing process of product fabrication processes are the second. The defects may be cracks, inclusions, segregate areas, porosity, or other nonhomogeneous structural features capable of creating a stress concentration. Solar's work on the mechanism of brittle fracture has led to the conclusion that closer control of the steel structure is essential to increase the toughness of the steel.

Control over the steel composition was also found to influence weldability. The effects of nickel and phosphorous combined were much more deleterious

e Practical

by A. T. Letsinger
Senior Project Engineer
Solar Aircraft Co.



Internal Medicine—B-70 Style

PINHOLES IN HONEYCOMB panels for the B-70 can be detected with this mammoth X-ray unit. North American developed the rig for production line quality control.

to the properties of H-11 steel than phosphorous alone, indicating that the ratio of these elements may be critical in high-strength weldments.

Similarly the degree of banding in this steel was found to affect material properties in the heat affected zones adjacent to welds. These discoveries clearly point out that 300,000 psi steel must start with recognition of new factors and unprecedented control over them by both the steel maker and the fabricator.

For the 300,000 psi case, it is highly desirable to keep joints to a minimum. Hence, shear forming or deep drawing is recommended as the preferred forming method. However, there are instances where joints are unavoidable; the Solar studies have included optimizing welds in steels with 300,000 psi potential.

It has been found that weld reliability is controlled by the solidification pattern, banding in the parent metal, composition of the steel, and other factors. Solar has been able to control the welding process so that welds with almost identical properties to those of the parent metal have been obtained. From this work Solar believes that 100% weld reliability is quite possible without any weld reinforcement at strengths up to 320,000 psi U.T.S. If these welds are confined to relatively low-stressed girth welds, welding will not impose a limitation on reaching the 300,000 psi yield strength goal.

Other characteristics requiring sophisticated control are weld bead geometry, internal defects, and weld distortion. A number of special processes have been developed at Solar to meet these needs. Oscillation TIG welding is applied mechanically to produce flat, regular welds on both sides of the metal, free of stress concentrators. Hydraulic pressure sizing is used to correct weld distortions. Multiple-pass welding is sometimes used for grain refinement. Seam forging of welds to minimize weld defects is another useful technique, and has been used in the shear spinning of roll and welded cylinders.

In view of these developments, Solar Aircraft believes that the 300,000 psi yield strength case is imminent. With the successful completion of the studies, the time is not far distant when such cases can be offered to industry as an important advancement in the search for lighter weight solid rocket motor hardware.

- **Exhaust effects**—New propellants with higher specific impulse have introduced a host of nozzle material problems. Nozzle materials technology has not kept up with advancements in propellant temperature, erosive characteristic, and duration of burning; consequently, current nozzles are seriously overweight.

Development objectives are to decrease this weight and at the same time increase the operating temperature and erosion resistance capability. Among the more important materials used in the development are tungsten in the nozzle throat backed up by a ceramic. This combination is successful uncooled up to 6000°F. For higher temperatures, which are predicted up to 8000°F, cooled nozzles will be mandatory, since tungsten, with the highest melting point of any metal, melts at 6170°F.

The main problem in the materials development are in forming and joining of tungsten. While major strides have been made in solution of these problems, further development needs to be done before these techniques will be available for general use. ⁑

Basics Stressed

Republic Takes Analytic Road

- *Potential of high-energy sources not yet achieved in spectroscopy and allied methods*
- *Gas chromotography being applied to describe high-temperature processes and effects*
- *Metal fatigue and brittle fracture under attack through solid-state theory*

by Dr. Samuel Korman
and
Dr. Robert Bastian
Republic Aviation Corp.

ADVANCES IN PHYSICS, chemistry and metallurgy at Republic Aviation Corp. are expected to provide new insight into materials development.

The Research and Development Center is actively promoting the application of specialized concepts to the evolution of new analytical techniques and composition control programs.

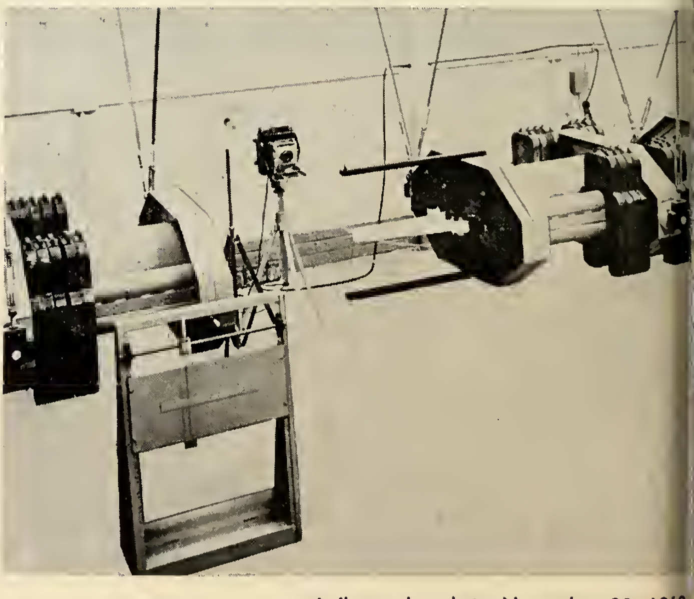
One illustration is the work being pursued in the estimation of trace impurities in high-temperature metal, alloys, and ceramic materials. This project is based on the belief that the key to better materials is more fundamental knowledge relating composition and properties.

In this connection, radically new concepts are being explored involving spectroscopy with high-energy discharges and similar sources that produce complete, rather than merely selective, vaporization of samples.

A factor here is the extension and modification of spectroscopic equipment and associated analytical tools. The applicability of these new techniques depends on whether instrumentation is available which can generate and analyze abnormally low signal-to-noise flame sources and photographic images.

• **Analytical methods**—There is strong feeling that the potential of high-energy sources in spectroscopy has not been fully appreciated. Unlocking this door will lead to greater precision in analysis of critical impurities. The concepts of high-intensity discharges and differential microphotometry are coupled together to yield more accurate data on materials composition.

These results will furnish better



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understanding of fabrication and service properties in connection with the refractories. Ultimately, Republic hopes to evolve analytical specifications to aid in specific materials designs and selection.

Another area of the laboratory's analytical efforts involves the application of gas chromatography to the description of high-temperature processes and effects upon materials. Working in close coordination with the advanced fluids laboratory, researchers use gas chromatograph equipment to segregate the components of service-tested fluid samples.

The chromatograph is a device which utilizes the physical chemical properties of specially prepared absorptive columns to sort out the components of the sample. These are then displaced sequentially through a recording device which produces characteristic curves related to the composition of the displaced component.

Running such analyses to identify the components of a sample makes it possible to describe the thermal degradation process in detail. Correlation with initial composition of the fluid, as well as the elimination of deleterious impurities, such as moisture, dissolved gases, extraneous chemicals and catalytic agents, can lead to improvement in service life, ceiling temperature, and other desirable characteristics.

Ultimately it is planned to extend the features of gas chromatography to the study of vacuum and radiation effects upon materials, such as plastics, which are sensitive to such space environmental factors.

- **Solid state involved**—Another important activity of the program lies in the area of the physics of materials. Solid-state theory is being applied to metal fatigue and brittle fracture phenomena. Under contract with AFSWC, advanced theories are being formulated on the role of dislocations in solids and the kinetics of the interactions to produce experimentally hypotheses of crack propagation and fracture that are verifiable. Also under investigation is the behavior of dislocations in the generation of microcracks within metals and alloys of specific composition.

These studies are intended to yield a better understanding of those characteristics of various metallic compositions which may influence crack formation and propagation so that fatigue and brittle fracture may be controlled or inhibited. Another objective is to learn in more detail how to utilize brittle materials such as refractory ceramics for structural applications.

The program in emissivity of materials is extending to the rational development design, and selection of materials with specified emissivity, absorptivity and reflectivity properties. More sophisticated equipment has been designed for these studies; it will include measurement of these properties over selected wavelength ranges, temperatures, and other environmental parameters.

In metallurgy, investigations are underway to evaluate tungsten alloy systems and protective coatings for refractory metal structures. Using the approaches dictated by controlled composition and advanced processes, comparisons are made of electron beam melted alloys with the vacuum arc products for properties at temperatures up to 4000°F.

Associated with this effort, considerable attention is being given to critical appraisal of refractory coatings compositions and modes of application, with a view toward establishing a reliable base for manufacturing development and for service specification in hot structures.

There is further emphasis on the evaluation of metals and ceramics by support in areas of metallography, X-ray analysis, and electron microscopy. Experts in these fields are devising new techniques for analysis of substructural changes in refractory metals and high strength steels. These changes are correlated with fabrication or service, with the purpose of understanding the changes in the metals brought about by such factors. Experience gained is used to improve materials selection and specifications.

The utilization of ultrasonic energy is still another phase in Republic's program. In this area, such phenomena as control of nucleation and grain size, and materials aspects of ultrasonic joining are of interest.

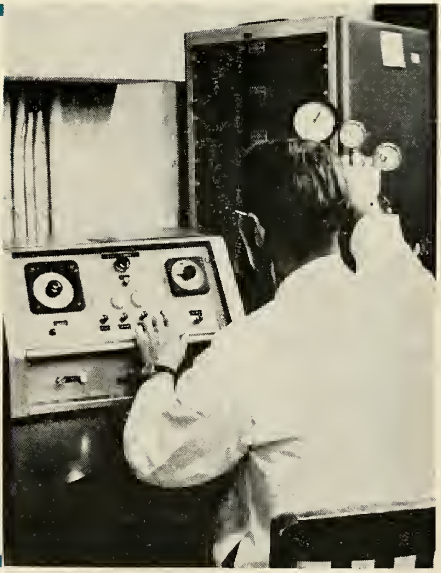
In the field of plastics and composites, the materials laboratory is concentrating upon evolution of improved ablation systems and radomes.

Republic looks to its materials development laboratory, and to the use of modern concepts and equipment of metallurgy physics and chemistry, to provide the materials information needed to insure successful design and manufacture of aerospace system of the future.

⁂

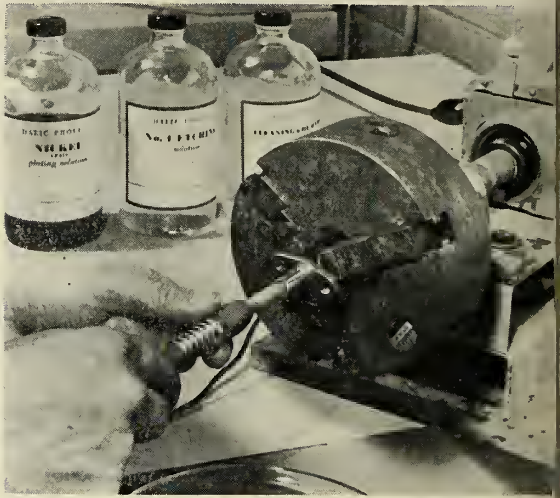
Re-entry Drag Studied With Cannon

A helium-activated gas gun at Fabric Research Laboratories fires a 75 mm projectile at pendulum supported specimens. Tests simulate the impact strains drag devices undergo when deployed from a fast-moving vehicle. A second weighted pendulum stops the projectile and aids in precise velocity determinations.



Selective Electroplating Save

- ***Dalic Process permits on-the-job plating without need for immersion.***
- ***Costly over-machined or worn missile components are now being reclaimed by manufacturers using technique.***
- ***Standard or precious-metal deposits of high purity and excellent quality are controlled to within 0.0001 inch.***
- ***Harmful electrical shock is avoided; plating solutions are non-toxic.***



FUEL INJECTION nozzle for turbine after-burner receives 0.0004 to 0.0006-in. plating of nickel on inner diameter and chamfer.

by Charles D. LaFond

A PROCESS OF SELECTIVE plating without the need for immersion is being used by many missile component manufacturers today to save time and money.

It is not used solely for protective plating. The technique has been employed regularly to reclaim intricate and costly parts that are worn or have been tragically over-machined during manufacture.

Called the Dalic Process, it was developed by J. J. Georges Icxi of Laboratories Dalic, Paris, France. Sifco Metachemical, Inc., of Cleveland, is the sole U.S. licensee for its manufacture and distribution here.

The only equipment needed is special hand-stylus plating tools, a power pack, and kit of Dalic plating solutions. The equipment may easily be carried to the job, and it is adaptable for mechanized production.

Most significant attribute of the Dalic Process is that it can be used to deposit metals quickly in places where conventional plating might be extremely difficult or even impossible. Because the process is suitable for selective plating, components need not be disassembled.

Solutions used are non-toxic and harmful electrical shock to the user is impossible.

• **Plating by painting**—Prior to actual plating, the surface must be prepared with electro-cleaning and/or etching solutions. These are applied with a stylus and an electrode. The surface is then water rinsed.

To plate an area—large or small—an anode pad is saturated with the desired metal-plating solution and rubbed over the applicable surface. The surface itself is made cathodic.

This simple procedure is followed until the desired plate thickness is attained. The power pack includes a finely graduated ampere-hour meter which indicates deposit thickness. Thickness, according to Sifco, can be controlled to within 0.0001 inch.

Very rapid deposition is achieved by the unusually high current densities used—that is, compared with conventional bath plating.

The completed plating job resulting from this process is a deposit that is fine grained, possesses excellent adhesion, has low stress, and is free from porosity, Sifco asserts.

Deposits reportedly are of consistently high purity and are harder than those achieved in conventional plating (except for chromium). In addition, the company maintains that hydrogen entrapment which might cause embrittlement does not occur.

• **Varied missile use**—To find out just how the Dalic Process has been used in the missile industry, M/R called on several manufacturers of key components. These are some of the responses and applications for which the technique has been used successfully:

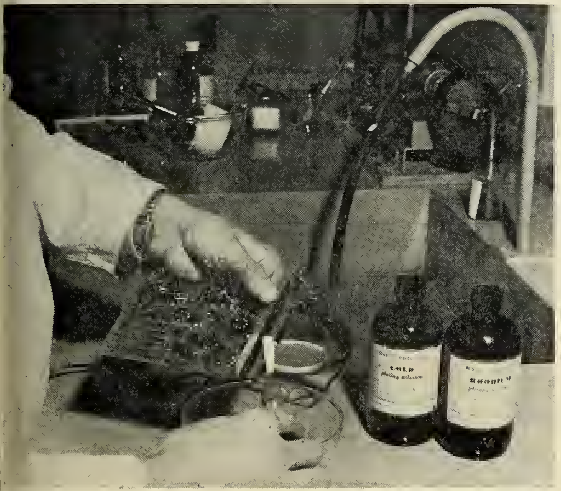
The missile launching valves used in the compressed air system aboard the submarine USS George Washington are a good example of how this technique cut normal lead times and solved problems in the *Polaris* program.

Exposed to a hostile sea water environment, these missile launching valves nevertheless must be capable of instantaneous action even after prolonged periods of inactivity, as might occur when the submarine cruises on-station for periods of several months.

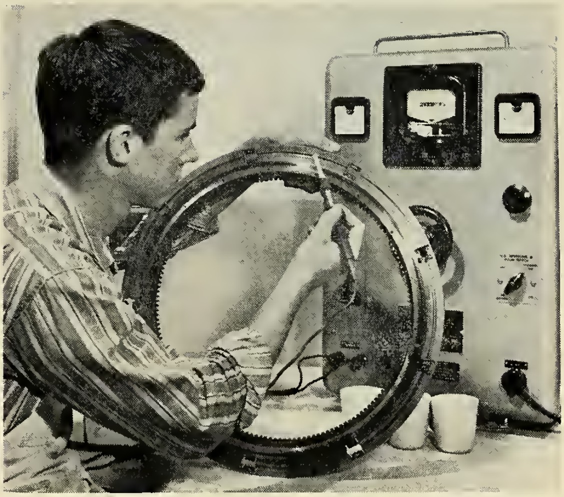
A protective plating was decided upon to keep the valve body interiors, face plates and O-ring seal areas free from corrosion. This protective plating could have been applied by conventional electroplating, using tank immersion methods. But this would have required sending the launching valves to a special plating shop, with resulting time losses. Instead, the Navy decided to undertake the protective plating job right at dockside, using the Dalic electroplating process.

In applying the specified 0.003-inch protective plating, the Dalic stylus, wrapped with a cotton swab (anode), was dipped in a special indium-tin alloy plating solution and then rubbed over the exposed valve sur-

ime and Dollars



PREVIOUSLY ASSEMBLED printed circuit board is given a 0.000050-in. plating of gold on all of its contact tabs.



DALIC PROCESS is used at Custom Tool & Mfg. Co. to "paint" thin groove on missile guidance gear with 0.0003-in. copper plate.

face (cathode) to be protected.

Despite the comparative ease and dispatch with which this valve plating job was accomplished, the resulting indium-tin alloy coating reportedly is both dense and highly wear resistant. In fact so much so that, according to naval engineers, the plating procedure is expected to prevent indefinitely any valve deterioration from sea water exposure. If touch-up plating is ever required, the process used for the original ob can be employed again.

The Navy reports the Dalic plating ob on the launching valves saved an estimated 800 hours over conventional methods in preparing the components or service.

Dalic selective plating has been used for many years as a special tool t Lycoming Division of Avco Corportion, Stratford, Conn.

Aircraft engine gears of all types nd sizes have been selectively touched-p by Dalic copper as a stop-off prior o nitriding or carburizing. These salvge operations, according to Lycoming, ave saved time and money and are a ontinuing operation.

Currently, Lycoming's missile prorams (including production of rentry vehicles for the *Atlas, Titan* and *Minuteman* missiles) have emphasized he need for special plating techniques. Missile assemblies and components are ow being processed by Dalic plating, not on a salvage or repair basis only, but as an initial manufacturing process.

A re-entry vehicle flare assembly, after proper preparation of the aluminum from which it is fabricated, requires an initial nickel plate, followed by a flash of gold and finally a silver plate of 0.0002 inch.

The interior of the nose cone backup structure is first zinc-chromated; then selective areas are plated. In a bath-applied plate these operations would have required extensive masking and plating procedures on large parts.

The unique advantages of the Dalic process eliminate the difficulties presented by orthodox procedures, and make it possible to confine masking and plating operations to only the limited areas involved.

Re-entry vehicle shelf and canister components undergo the usual involved preparations for plating on aluminum prior to a zincate, low pH copper plate, and final cadmium plate. Subsequent operations on these components frequently remove or destroy the plate in given areas.

The ability to "spot" plate exactly where it is needed has enabled Lycoming to re-cadmium plate the selective areas without difficulty or undue expense, says its engineers.

Future applications such as Dalic tin plate on stainless steel followed by fluxing and soldering are contemplated by the division.

Custom Tool & Manufacturing Co., Minneapolis, had a particular problem with the gear ring used in a large guidance system. Made from 4140 steel, a 0.0003-inch plating of copper was needed in a circular groove (see accompanying photo).

Because of the extremely tight tolerance (±0.0005 inch), plating by conventional methods would have been nearly impossible. To avoid the heat problems, intricate masking requirements, and the inherent danger of hydrogen embrittlement, the Dalic method was used successfully by the company.

Goodyear Aircraft Corp. in Akron, Ohio, employed the process to plate nickel on mis-machined internal threads of missile valve components. Plating was continued on each piece until an accurate fit was accomplished.

The company said it has used the process to salvage over 200 costly missile components which were out of tolerance.

Others who are successfully using this unusual technique in their missile work include Boeing-Seattle Div., Lockheed Aircraft Corp., American Bosch Arma, etc. The National Aeronautics and Space Administration at Langley has been using the process to plate precious metals on portions of satellites and space vehicle hardware. ⌘

Every breakthrough in military electronic equipment design creates new, complex and urgent problems in installation, modification, testin maintenance and personnel training. Hallicrafters radical new "Blue Streak" project—utilizing quick-reaction techniques—*offers experienced Hallicrafters support teams to assist key military personnel . . .* pinpoints problems in advance . . . solves them on the spot with new levels of speed and economy.

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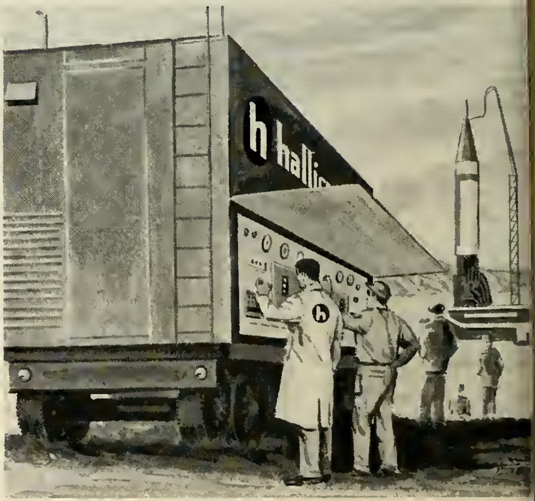

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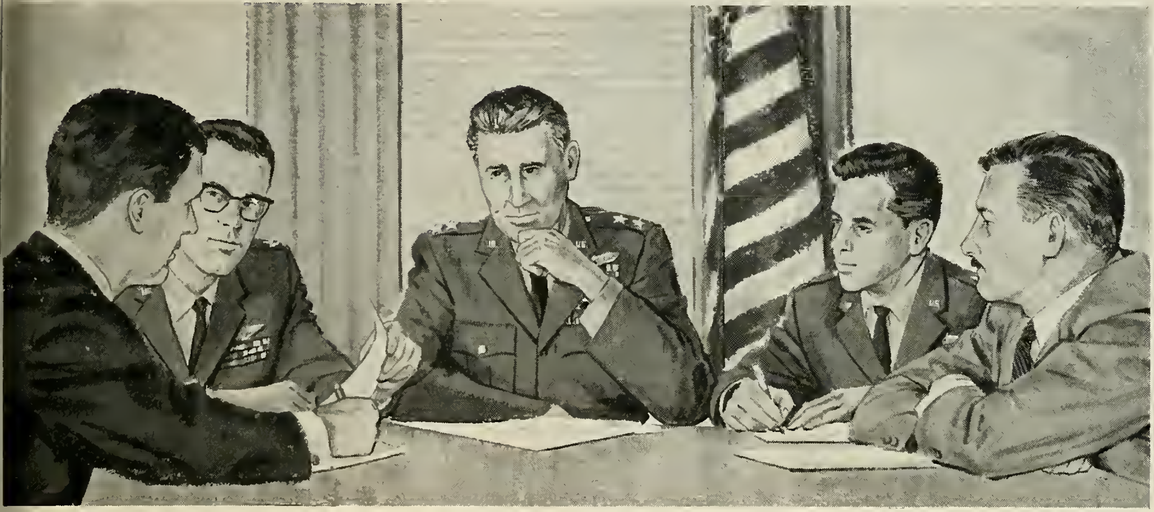
TEAMWORK IN PLANNING: Hallicrafters "BLUE STREAK" Teams provide electronic industry technology in support of military programming groups for SAC aircraft at OCAMA and other materiel commands.



TEAMWORK IN MODIFICATION: Modernization of RF transmission systems completed in 30% less time through "BLUE STREAK" team assistance to base maintenance groups.

TEAMWORK IN INSTALLATION: Advanced ECM equipments are installed by "BLUE STREAK"-SAC teams with a minimum of down time. Maintenance and operational training is speeded up, too.

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Re-entry Drag Devices Studied

- ***Decelerators expected to reduce the weight penalties suffered in thermal protection of returning vehicles.***
- ***Ideal material is still being sought, and its fabrication into a deployable structure will present additional problems. List of potentials is growing.***

by Myron J. Coplan
Assistant Director
Fabric Research Laboratories, Inc.
Dedham, Massachusetts

SUCCESSFUL PERFORMANCE of space vehicles will depend as much on safe recovery as on flawless launching.

This is conspicuously true for manned space flights, where both moderated deceleration and soft landing are mandatory.

Examples of the latter situation include even lift-surface vehicles (e.g., *Dyna-Soar*), which will probably require a last-stage decelerator much like the now traditional drag 'chute for jet planes. Non-lift orbiters (e.g., *Mercury* capsule, *Discoverer* nose cone) obviously call for last-stage parachute descent even though re-entry may occur without the aid of auxiliary decelerating equipment.

Landing or final descent maneuvers involve much lower levels of thermal stress on the decelerator than would occur at hypersonic speeds. More or less conventional parachute materials seem capable of serving the purpose. This is simply because the bulk of the vehicle's kinetic energy would already have been converted to heat and dissipated by processes of radiation, or transpiration, at speeds and altitudes much higher than those involved in terminal deceleration.

But it may not be desirable for the vehicle itself to provide all of the drag. The lower the drag-to-weight ratio, the denser the atmosphere at which deceleration occurs, and the more severe the heat stress. Consequently, considerable weight penalties may be suffered to protect the vehicle with heat shields, ablative surfaces, transpiration cooling systems, etc. The alternative would be to spread out the aerodynamic drag forces over longer times, at higher altitudes, by means of a deployable, expandable drag device. This allows more favorable overall drag-to-weight ratio in the hypersonic flight regime. An ideal device would also function in terminal deceleration and escape in the vent of abortive launch.

A number of expandable decelerator concepts are under consideration and at various stages of development. It appears axiomatic, in view of their intended use, that these must be built to sustain stagnation temperatures of some magnitude. A peak temperature of about 1500-2000°F must be endured for times in the order of seconds to minutes.

Survival of the decelerator also depends on resistance to oxidation at the temperatures involved. Not only is O_2 present but also possibly atomic oxygen and ozone, and even oxygen dissociated in the shock.

• **Functioning structure**—At first glance 15-minute durability in an oxidative environment at 2000°F may not appear too formidable to a materials engineer. But when the requirements "deployable" and "expandable" are imposed, the situation acquires some intriguing complexities.

It will be appreciated that the drag device weight and bulk must be minimized prior to deployment. It must present a high drag surface in operation. The achievement of appropriate deformability and elastic recoverability calls for a low-rigidity material capable of being compacted without permanent set or damage. But thermally durable materials are generally characterized by high modulus and low yield or rupture extension.

One fortunate situation arises when peak deceleration is dictated by the tolerance levels of humans: the stress capabilities demanded of the decelerator are not inordinately high. For example, to exert a maximum deceleration of 10 g (near human threshold) on a two-ton vehicle requires a total force of 40,000 lbs. Distributed uniformly and tangentially on the perimeter of a 30-ft.-diameter hemisphere, this force results in a stress of on
40 lbs. per inch width.

Thus a foil only 1 mil thick cou
sustain the peak load if it had a tensi
strength of 40,000 p.s.i. at peak he
Since it happens that peak stress ar
peak heat generally do not occur at t
same point in time, there is a safe
factor built into the calculation.

The drag device must have a hi
emissivity. Essentially all the heat flo
ing into the canopy, balloon, or un
brella must be lost by radiation. T
light weight and low bulk of the dr
device is such that heat-dissipati
tactics are difficult if not impossible.

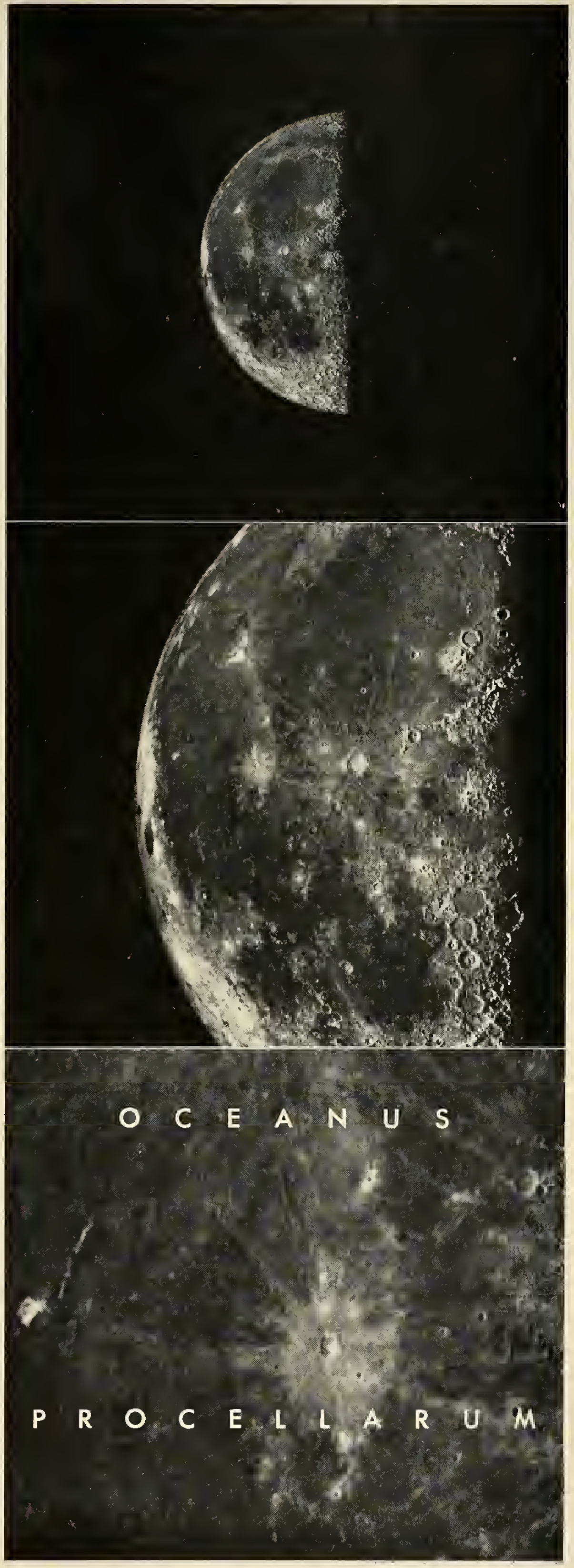
It was inferred in the sample ca
culation for stress that foil structur
might be useful. Actually, design co
siderations indicate that more near
textile-like materials are desirable. The
require fibers for their fabrication. Th
range of potentially useful materia
available in fiber form may be arb
trarily classified as metallic, ceramic
or carbonaceous.

Wire cloths of semi-conventiona
type but composed of high temperatur
alloy wires are being investigated a
canopy fabrics for inflatable structure
and as the membrane on a folding-stru
umbrella system. All of these requir
a flexible heat-durable coating to con
trol or eliminate porosity.

The coated wire-cloth materials ar
by no means ideally compactable an
recoverable. The principal drawback i
the limitation on the diameter of con
ventionally wire-drawn filaments. Th
ultimate structural unit would be
bundle of wires, each wire being i
the order of ¼ to ½ mil in diamete
Strength, flexibility and recovery ca
be achieved if the wire diameters ar
fine and large enough bundles ar
assembled.

Ceramic fibers, particularly con
tinuous filament fused quartz, are avail

(Continued on page 63)



SPRINGBOARD FOR SPACE: LUNA

The moon is a ready-made space station for interplanetary exploration; space vehicles could be built, fueled, and launched there; lunar elements could be used to give man independence from earth. To help make this concept a reality, NAA's Missile Division has integrated the ideas of scientists in many fields and is studying how to reach the moon... how to live in its alien climate... how to process lunar matter. One example: a study of processes to obtain water from materials likely to be found on the moon.

THE MISSILE DIVISION OF
NORTH AMERICAN AVIATION, INC.
Downey, California

Dyna-Soar Demands Exotic Materials

- ***Performance requirements force designers into superalloys and refractory metals***
- ***Ceramics confined to non-structural areas***
- ***Detail components exert considerable influence***
- ***Materials must match aircraft standards***

SECOND-STAGE Titan booster falls away in artists conception, leaving Dyna-Soar in piloted, near-orbital flight.

by M. A. Nelson

Chief, Dyna-Soar Structures Technology
Aero-Space Division
Boeing Airplane Company

THE EXTENT TO which construction materials can withstand widely varying thermal environments must obviously be a major controlling factor in the re-entry performance of space vehicles.

This is equally true for pure ballistic, pure glide, or combinations of these. An intense, short-term thermal environment is characteristic of ballistic re-entry; glider-type vehicles experience relatively long heating periods of lesser intensity.

Space missiles of several varieties have demonstrated the capability of materials systems to survive a single ballistic re-entry, but re-entry vehicles based on the glide concept are in the early stages of development. The *X-15* program is providing an initial step in the exploration of the fringes of manned glide re-entry. The *Dyna-Soar* program will continue and extend this exploration.

The thermal environment associated with a space vehicle such as *Dyna-Soar* is the paramount reason why materials engineers and designers are being forced to turn to materials and methods of construction which are new to aircraft applications.

• **Other effects**—But we must also recognize the numerous attendant effects of hypervelocity flights within and outside of the earth's atmosphere. Oxidation and erosion of materials used for the external surface of the vehicle is accelerated by high-velocity air, high structural temperatures, micrometeorite abrasion, and ionized and dissociated gases. The near-vacuum conditions encountered in orbit affect the properties of many materials, causing certain metals to become stronger and less ductile, conventional lubricants to evaporate, and thermal insulations to improve in efficiency. For orbits beyond a few hundred miles, the degradation of effects of cosmic radiation on organic materials must be considered.

Secondary radiation from certain materials, resulting from impingement of cosmic radiation, can be deleterious to humans and equipment. The combined effects of these and other pertinent operational environments must be given attention before the final selection of materials of construction for re-entry devices.

Before the Space Age, the aircraft designer had access to a large selection of thoroughly tested materials for structural applications. Here the principal considerations were strength, weight, reliability and economy.

• **Exotic materials common**—The demands for increased performance from re-entry vehicle materials have focused the designer's attention on such nonconventional aircraft structural materials as the superalloys, refractory metals, cermets, ceramics and various composites.

The high nickel- and cobalt-base superalloys retain usable strength up to 2000°F. These alloys suffer rapid surface oxidation above 1300°F, with certain alloys tending toward intergranular oxidation. The surface oxidation can be adherent, however, with a tendency to prevent further oxidation while also providing a desirably high-emissivity surface. Intergranular oxidation, on the other hand, adversely affects both the strength and ductility of the metal.

With the exception of Inconel X structure such as that used on the *X-15*, fabrication of aircraft-type hardware from superalloys has been accomplished only on an experimental basis. In fusion welding of superalloys, considerable attention is being directed toward attaining the filler wire selection, welding control and heat-treatment processing necessary to produce ductile welds of aircraft quality.

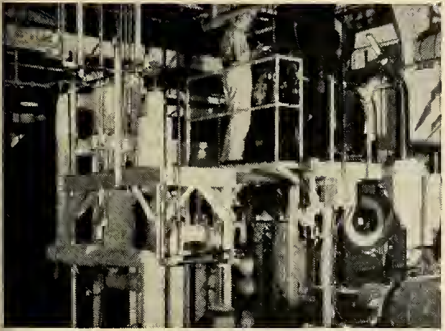
Industry experience in the production of superalloy materials has likewise been limited, and using contractors therefore find problems in obtaining material in production quantities which possess consistent mechanical properties. This is notably true for sheet gages less than 0.020 inches and

(Continued on page 54)

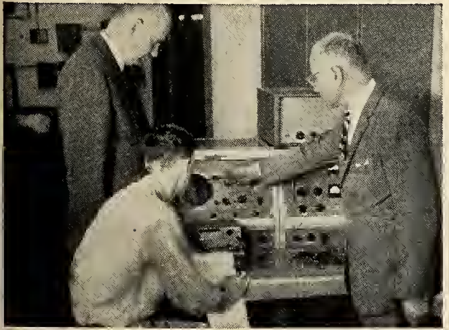
FORECAST

Major space age role for fluorine rocket fuel oxidizers

25,000 POUNDS OF LIQUID FLUORINE, from General's Metropolis, Ill., Works – ready for over-the-highway shipment in tank trucks of our own design to rocket and missile research centers throughout the nation.



CHLORINE TRIFLUORIDE has been produced commercially by General Chemical for the past 10 years. Reactors like this one, located at General's Baton Rouge Works, have a capacity of more than 100 tons of CTF per year.



GENERAL CHEMICAL SCIENTISTS make use of the most advanced scientific equipment to investigate fluorine compounds as high energy oxidizers for solid propellants.

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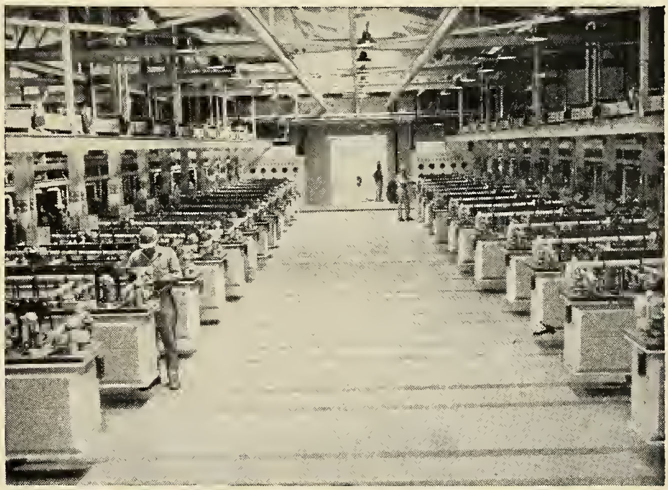
In solid propellant systems, General is conducting intensive investigation under Government contract. Incorporation of the fluorine atom in the oxidizing molecule is part of this research.

If you would like technical data, we will be glad to send you our free bulletins, "Fluorine" and "Chlorine Trifluoride." Simply request them on company letterhead.



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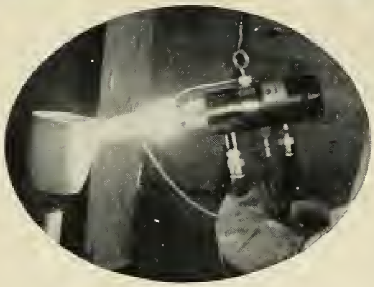

Apply coatings of high melting point materials such as tungsten, tungsten carbide, molybdenum, chromium carbide, titanium oxide, rare earth oxides. Operates at 10,000°-15,000°F.

Now any material that can be melted without decomposing can be sprayed. Despite high melting temperature, object sprayed stays cool.

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Materials Gap Gets Worse

(Continued from page 27)

be the key to important technological advances leading to improved defense systems. Basic knowledge of what makes materials strong, ductile and brittle in crystalline, foamed, filament- and particle-reinforced and laminated structures concerns the solid state mechanics of matter.

Individual experiences with metals, ceramics and plastics have served to re-emphasize the importance of a materials-science approach. Basic understanding of the fundamental behavior of materials has benefited when the two fields have shared knowledge.

• **Molecular understanding**—In the final analysis each materials discipline must concern itself with the aggregation of atoms and their growth into a structure, identification of what constitutes and determines a perfect and what an imperfect structure, and h
a bulk solid is thereby constructed.

The physical metallurgist is famili
with nucleation and growth, cryst
structure, impurities and imperfectio
and microstructure, because these
search subjects have occupied h
interest in understanding basic me
and alloy behavior. A similar approa
to ceramics and plastics has clea
shown the long-term value of bas
materials research in solving o
engineering materials problems.

In summary, knowledgeable app
cation and development of materia
for current engineering problems c
best be achieved through the establis
ment of a materials technology who
precepts are well founded on a fund
mental understanding of matter.

Re-entry Taxes Structures

(Continued from page 50)

for standard shapes and parts as fasteners, angles and tubing.

Above 2000°F the refractory alloys such as columbium and molybdenum are the only metals which are currently available and suitable for airframe applications. Alloys of both these materials require oxidation-resistant coatings. These coating processes are generally involved and difficult to apply to complex structural components. For the time being, therefore, the designer is limited to relatively small, simple components if his coating application is to be reliable in all respects.

Coating processes which require diffusion of a dissimilar material into the surface of the refractory metal may embrittle and reduce the strength of the refractory base metal. If the refractory base is welded, embrittlement may also occur, due to recrystallization in the heat-affected zone or absorption of gases into the weld. Truly reliable coating and welding of refractory alloys will emerge when adequate process controls are developed.

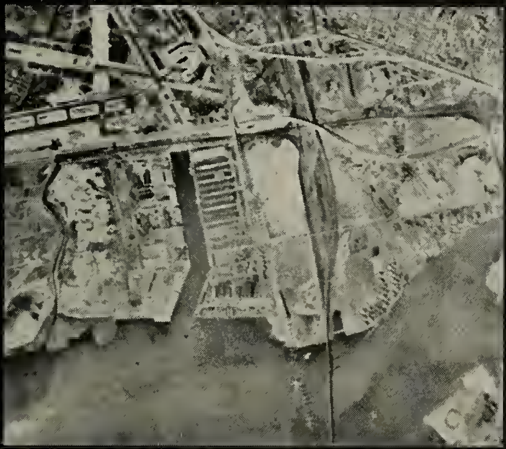
• **Ceramic potentials**—For the extreme temperature areas of re-entry vehicles (such as at the stagnation regions), the high-temperature ceramics, cermets and composite metal-ceramic structures display better survival characteristics. The inherent lack of ductility, sensitivity to thermal shock and low strength exhibited by most of these materials has forced the designer to re-orient his thinking away from conventional design practices.

In general, it has been found desirable to restrict the use of these materials to applications which are no
structural in nature.

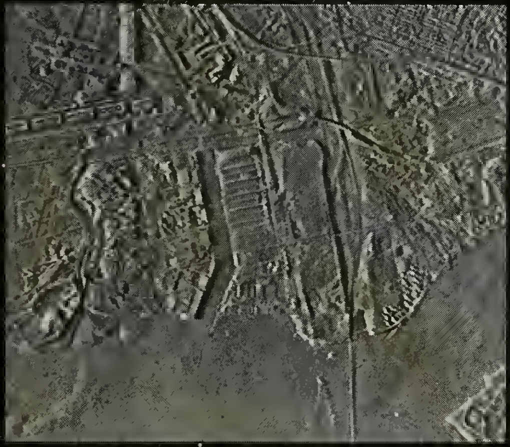
Detail components essential to t
fabrication of the structure—such
bearings, mechanical fasteners, lub
cants, seals, insulations and transpa
ents—can exert considerable influen
on the structural concept, arrangeme
and fabrication of the total vehic
Blind fasteners are not now availab
in the high-strength superalloys or
fractory alloys. Ordinary windshie
materials common to present-day ai
craft will not meet re-entry vehic
design requirements for optical m
terial. A shift to higher temperatur
capability materials such as pure quar
is necessary.

Continued development is requir
for seals, sealants and insulations wi
varied thermal capabilities, from nea
room temperature in crew and equi
ment compartments to the extern
high-surface temperatures for aer
dynamic sealing.

• **Triple threat design**—The cha
lenge to re-entry vehicle structural d
sign and construction is essential
threefold. The structural designer mu
learn to arrange new materials of co
struction into concepts and arrang
ments which are foreign to conve
tional aircraft structures. The metho
of producing these materials in nece
sary shapes, forms and sizes must
further developed in order to atta
accepted aircraft quality standard
Finally, the processes for fabricati
these materials into reliable structur
components must be continuously i
proved and refined.



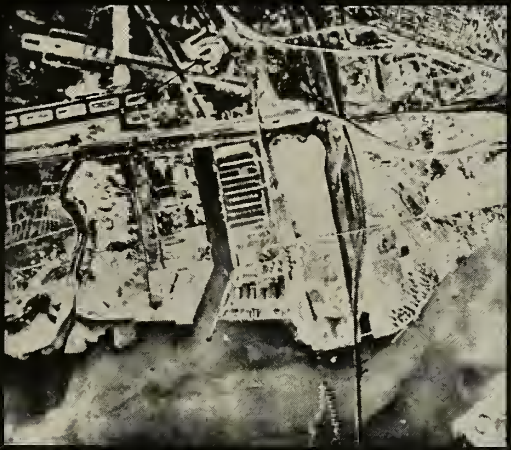
1. RCA IMAGE ENHANCEMENT SYSTEM produced this high-quality 1000 TV line resolution image from an original aerial photograph.



2. ELECTRONIC DIFFERENTIATION OF ORIGINAL PHOTO gives a three-dimensional appearance useful in synoptic observations.

RCA Image Enhancement Techniques

Give New Dimension To Visual Data



3. ELECTRONIC SLICING CONTRAST STRETCH in the intermediate level is an enhancement technique useful in object recognition.

◄ RCA Imagery Simulator and Enhancement Console

Image Enhancement, a new approach to photo interpretation developed by RCA Astro-Electronics Division, brings out hidden information from visual data. The RCA Image Enhancement Console quickly makes visible a wealth of information the unaided eye might not discern, by electronically emphasizing and/or de-emphasizing selected qualities inherent in any pictorial presentation.

Here are some of the ways the RCA Image Enhancement techniques aid image interpretation and information extraction:

- **SLICING**–Contrast "stretch" or video slicing provides increased contrast in a desired portion of the gray-scale transfer characteristics. It gives new vividness to selected details.
- **OUTLINING**–This produces an outline or contour of constant intensity, and of either polarity, along the loci of a selected video gray level. It emphasizes lines or areas of equal brightness quickly and is especially useful in delineating nebulous objects such as cloud formations.
- **DIFFERENTIATION**–This technique extracts interesting bas-relief effects and three dimensional light and shadow effects from pictorial information. It facilitates synoptic observations.

Image enhancement techniques are currently in experimental use. Applications in meteorology may include aid in interpretation of cloud cover photographs such as were taken by Tiros I. Enhancement techniques can aid in interpretation of all photographs taken during aerial and space reconnaissance missions. Unique image sensing methods such as radar, infrared and ultra-violet may benefit by enhancement. Medical and industrial x-ray analysts are extremely interested in the advantages which image enhancement may offer. Astronomers feel that these techniques will aid in their interpretation of photographs of the heavens. New applications are constantly being considered.

If you would like to fully explore the unique capabilities of the RCA Image Enhancement techniques, RCA's Space Center will welcome the opportunity to discuss them with you. Contact the Marketing Manager, RCA Astro-Electronics Division, Princeton, New Jersey.

If you are interested in participating in such challenging team efforts, contact the Employment Manager at RCA's Space Center.

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General Electric Silicone Rubber finds dozens of uses in missile systems. How many more will prove vital?

General Electric silicone rubber has the "thermal toughness" to stand up under the searing heat of rocket blast-off or possible atomic attack. Add very good electrical properties and excellent resistance to aging, weathering, moisture, flame, ozone and corona and you can easily see why silicone rubber is now being used in virtually every U.S. missile and space vehicle.

Since both space technology and silicone rubber are relatively new, General Electric believes there are many more areas not yet explored where silicone rubbers can help keep a missile functionally reliable and combat-ready. To help designers in their evaluation work, we list here the principal properties and applications of G-E silicone rubber.

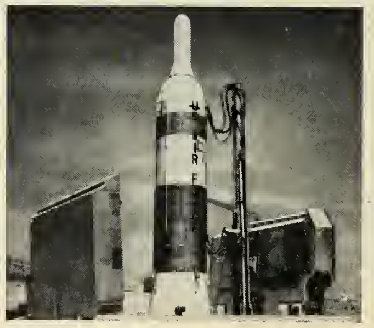
RTV LIQUID SILICONE RUBBER — One of the most versatile materials developed in recent years, RTV is a liquid rubber that cures at room temperatures. Like all silicone rubber, it remains flexible over a wide temperature range and is virtually ageless. Since it comes in a wide range of viscosities, it can be poured, sprayed, dipped, painted or applied with a pressure gun or spatula. It bonds tightly to metal when a primer is used. When not primed, you can readily remove RTV and then reapply more. You can impregnate tightly wound coils with RTV or form sections several inches thick.

You can control cure time from two minutes to 24 hours. These are RTV's typical properties:

Viscosity	from 120 poises (very pourable) to 12,000 poises (paste)
Specific Gravity	1.2 to 1.5
Solids Content	100%
Shrinkage	0.2%
Heat Resistance	from —90°F to 600°F, and as thermal insulation, in 5500°F flame for minutes
Ozone Resistance	Comparable to Mica
Electrical Properties	See last table

Applications—RTV is used as a high temperature structural sealant in missiles, satellites and space vehicles. It is used to pot and encapsulate electronic components and assemblies for electrical and heat insulation and for protecting delicate components from physical damage. It is commonly used as an impregnating insulation in transformer coils, to pot and hold cable in raceways and to pot cable breakouts. You can make flexible molds with RTV and hence make accurate, duplicate castings from originals.

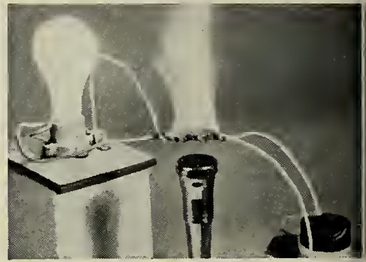
RTV is an excellent thermal barrier and as such is applied on and around missile nozzles. Tests show RTV's resistance to flame temperatures as high as 5500°F for several minutes. RTV also functions as a flexible ablative material and is used around probe holes, along raceways, and between stages and structural joints on the missile skin.



HEAT CURED SILICONE RUBBER PARTS —Silicone rubber gaskets, port seals, O-rings, shock mounts and other mechanical parts are not only used on missiles but have wide application in ground support equipment. For instance, missile silo doors use silicone rubber seals that will stand up to outside weathering, ozone and abuse for years and which will also resist the heat of missile launching and nuclear attack. Silicone rubber also resists brief exposure to cryogenic materials.

Silicone rubber has long-lasting temperature resistance from —150°F to 600°F, with excellent electrical, weathering, ozone, corona, radiation and nonaging properties at these temperatures. High tensile strength and low compression set are also within its range of desirable properties:

Tensile Strength, psi	800—1500
Elongation, %	100—600
Hardness Durometer (Shore A)	25—80
Compression Set, %	10—80
Tear Resistance lb/in	40—200
Radiation Resistance	1 x 10^8 roentgens
Electrical Properties	See table below



WIRE AND CABLE INSULATION — The long term reliability of silicone rubber when operating in high ambient temperatures and when current over-loads cause the conductor to approach 500°F is an important feature of silicone insulation. In an 1800°F flame, specially constructed silicone rubber insulated cables will continue to insulate for hours, forming a non-conductive ash that gives off no toxic fumes. And short term reliability is obtained even when silicone rubber is exposed momentarily to a direct flame of 5500°F.

Because of this excellent heat resistance, more current can be carried than in conventional cable (or smaller cable can be used). Other features: best compression set of all elastomers at temperature extremes, so that silicone rubber wire and cable does not deform under clamps; high ozone, corona, radiation and weather resistance, low moisture absorption, flexibility down to —100°C. These are the typical properties:

Volume Resistivity	10^{15}—10^{16}
Dielectric Strength, volts/mil	600—650
Dielectric Constant, 60 cps	3.0
Power Factor	.0010—.0050
Radiation Resistance	1 x 10^8 roentgens
Physical properties	Similar to table above.

Applications—Wiring harness made of silicone rubber insulation is often found throughout missiles. Cable offers added reliability for use in various places throughout the launch complex below ground from power plant to silos. All combat vessels built for the U.S. Navy during the last ten years, including fleet ballistic missile submarines and the new nuclear-powered cruiser and aircraft carrier, have silicone rubber insulated cable installations in all fixed wireways. In every case, silicone rubber is chosen because it is virtually non-aging, stands up to intense heat better than any other flexible insulating material, and continues to operate even when subjected to fire.

●

There are many more places where G-E silicone rubbers' inherent properties can be vital in missiles, satellites and space vehicles. For further data, call your nearest G-E sales office or write Section 01133, **Silicone Products Department, General Electric Company, Waterford, New York.**

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Tiros II Will Bring Weather Satellite Speedup

Success of Nov. 23 launch causes NASA to reconsider present plans; Soviets bid for 'joint project'

BROADENING AND SPEEDING of the U.S. weather satellite program is in prospect as a result of the success of *Tiros II.* Meanwhile, the Soviets are trying to promote a cooperative international weather satellite program.

Dr. Morris Tepper, chief of meteorological satellites for the National Aeronautics and Space Administration, said after the Nov. 23 launch that plans for one more *Tiros* in 1961 and a series of four *Nimbus* satellites beginning in 1962 were "as of before 6:13 this morning" and will be reconsidered.

Tepper did not elaborate on how the program could be speeded. He conceded that lead time built into the procurement schedule will make it difficult to accelerate the *Nimbus* launch. NASA will request bids on a *Nimbus* prime contract in the next week or so, he said, and will need three or four months to get a contractor aboard.

The NASA weather chief said he has no objection to a system of international sponsorship and control apparently sought by the Soviets and added, "It would be a wonderful thing for meteorology."

- **Russian Proposal**—In a paper issued by the Soviet Embassy on the same day as the *Tiros* launch, Prof. G. Pokrovsky, a Soviet space scientist, proposed a worldwide system of weather satellites as "a joint project for all countries."

Dr. Francis W. Reichelderfer, Chief of the U.S. Weather Bureau, reported that Soviet meteorologists had shown great interest in *Tiros I* data when he showed it to them at a meeting of the World Meteorological Organization in Geneva last summer. Reichelderfer said he gained the impression that the Soviet space program did not include meteorological satellites at present.

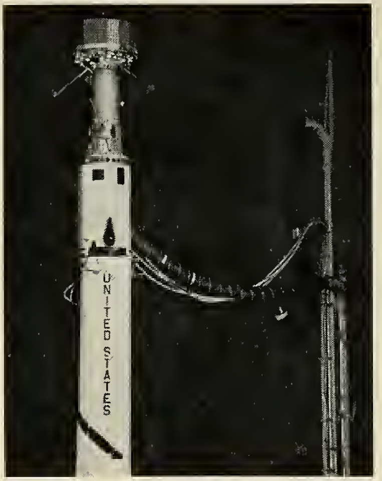
- **Tiros Changes**—First information from the instruments aboard *Tiros II* was that all were working well with the possible exception of the wide-angle television camera. Quality of the first wide-angle pictures was not as good as those from *Tiros I.*

Tiros II differs from the first weather satellite, launched April 1, in two major respects. The new 280-lb. satellite, 10 lbs. heavier than the original *Tiros,* carries infrared observation to measure the amount of solar heat absorbed and reflected by the earth, to provide a new tool for understanding the weather.

A second difference is a wide program to test and evaluate cloud cover maps as an aid to operational military and civilian forecasting. The program is still an experiment, but it is an experiment in the practical use of the cloud data.

The infrared equipment consists of two experiments. The first, which scans by a combination of the satellite's rotation and motion of the satellite in its orbit, consists of five sensors. These measure earth albedo at 0.2-5 microns, radiation of earth and atmosphere together in the 7-30+ micron range, earth radiation in the 8-12 micron "window," 6.3 micron water vapor radiation from 25-30,000 ft. altitude and a 0.5-0.7 micron visual channel.

The second IR experiment has two sensors, one white and one black, which measure the total heat balance of the area viewed by the wide-angle TV camera. The TV cameras, one covering an area 100 miles wide and one covering 800 to 1000 miles, are similar to those on *Tiros I.*



TIROS II weather satellite awaits launch from Thor-Delta at the Cape.

To provide a calibration of the IR data, identical IR experiments were launched by a balloon from

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Like the rest of the facts? A full page in ELECTRONICS for October 7 tells more, or write us and descriptive literature (plus a copy of the ad) is yours for the asking.

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Sioux Falls, S.D., a few hours before *Tiros II*. The balloon, which apparently became caught in the jetstream, caused a rash of UFO reports thoughout the Midwest.

- **Not a missile spotter**—The IR equipment aboard *Tiros II* would be of no value for detecting missile launchings, NASA's John W. Townsend declared, because its resolution of five degrees means that any individual signal covers an area of 900 square miles. Even the largest rocket would not radiate enough heat to be detected against the background level from such an area, he pointed out. And, as they said at the time of *Tiros I*, NASA spokesmen repeated that the resolution of the TV cameras would be no help toward military surveillance. Resolution of the narrow-angle camera is 0.2 mile per TV line.

The Weather Bureau is using its National High Altitude Facsimile Network to transmit the so-called Neph Analyses—maps of cloud cover superimposed on regular weather maps. Production of the Neph analyses was to begin within three or four days after launch, after exact information on the satellite's attitude, spin rate and orbital elements were obtained.

Military weather services will also make widespread use of the maps.

Another new item aboard *Tiros II* is a magnetic orientation control. After some time in orbit, the satellite precesses *Tiros II* carries some loops of wire for setting up magnetic fields that can be activated by ground command to interact with the earth's magnetic field and return the space-craft to the desired orientation.

The satellite, shaped like a pillbox, measures 42 in. in diameter and 19 in. high, and is covered with more than 9000 solar cells to power five transmitters and other equipment. The initial orbit, with apogee of 431 statute miles and perigee of 406 miles, was the most nearly circular orbit ever achieved. Period is 98.2 minutes, and inclination is 48.3°.

Astro-Electronics Division, RCA, designed and constructed *Tiros I* and *II*, and was responsible for special ground equipment. Barnes Engineering Co. provided the IR detectors. Douglas Aircraft Co. manufactured both stages of the *Thor-Delta* launch vehicle, with Rocketdyne first-stage engine, Aerojet-General second-stage and Bell Laboratories command guidance, using a Remington Rand Univac computer.

The Army Signal Corps Research and Development Laboratory, Ft. Monmouth, N.J., and the Navy's Pacific Missile Range at San Nicolas Island, Calif., operated the two ground stations. RCA has a backup ground station at Princeton, N.J. ⌘

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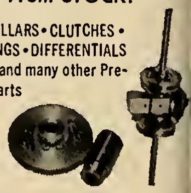

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—contracts—

NASA

Westinghouse Electric Corp., Pittsburgh, for supplying a high-energy arc heater to be used in a wind tunnel at Moffett Field. Amount not disclosed.

270,850—Controls for Radiation, Inc., Cambridge, Mass., for operational services at Plum Brook Nuclear Reactor Facility near Sandusky, O.

NAVY

General Electric Co., Lynn, Mass., for conducting studies on the use of a lightweight gas servo system for thrust vector control for the *Polaris*. Amount not disclosed.

26,000,000—Bendix Corp., Bendix System Div., Ann Arbor, Mich., for continued development and evaluation of the *Eagle* missile.

8,000,000—Vitro Laboratories, Silver Spring, Md., for continued coordination and testing of *Polaris* weapon systems on nuclear-powered submarines.

885,000—Vitro Electronics Div. of Vitro Corp. of America, for a portion of the systems engineering and instrumentation of two Victory ships being demothballed for tracking duty with the PMR fleet.

194,177—University of Southern Calif., Los Angeles for design and production of a high-altitude environmental test chamber.

AIR FORCE

2,300,000—Westinghouse Electric Corp., Pittsburgh, for continued development of molecular electronics systems.

1,150,853—Goodyear Aircraft Corp., Akron, O., for additional contractor maintenance work and supplies for the TM76A *Mace* missile program.

1,000,000—Magnavox Co., Ft. Wayne, Ind., for components of AN/ARC-34 radio sets plus spare parts and ground support equipment.

666,000—The Twin Coach Co., Buffalo, for electronic consoles for the *Hawk* system. Subcontract from Raytheon Co.

400,000—American Brake Shoe Co., Kellogg Div., Oxnard, Calif., for hydraulic pumps for the GAM 77 *Hound Dog*. Subcontract from North American Aviation's Missile Division.

151,000—Minneapolis-Honeywell Regulator Co.'s Special System Div., for development and production of guidance compartment cooling systems for the *Minuteman*. Subcontract from North American Aviation, Inc.

ARMY

5,375,000—Goodyear Aircraft Corp., Akron, O., for continued *Nike-Zeus* research and development.

4,947,000—Food Machinery and Chemical Corp.'s Ordnance Div., San Jose, Calif., for design and development of the *Mauler's* vehicle and pod assembly.

4,920,002—Thiokol Chemical Corp., Bristol, Pa., for continued production of rocket motors.

3,267,396—Raytheon Co., Waltham, Mass., for engineering services on the *Hawk* missile system. (Two contracts).

1,995,000—RCA's Defense Electronics Products Div., Moorestown, N.J., for fabricating the new missile tracking equipment for a missile tracking and measurement vessel.

1,118,934—Intercontinental Manufacturing Co., Garland, Tex., for manufacturing metal parts for rocket motors.

330,000—Raytheon Co., Waltham, for *Blue Streak* emergency replenishment repair parts, *Hawk* missile system.

MISCELLANEOUS

1,648,000—Grumman Aircraft Engineering Corp., for modification of the SA-16 *Albatross* for use as an antisubmarine warfare aircraft.

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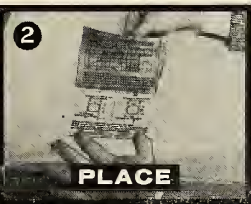

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Epoxy Hermetic-Seal Bushings

Designed for solder-in installation into hermetically sealed metal equipment enclosures, Model M-1003 Hermetic-Seal Feed-Through Bushings constructed of solid cast-epoxy resin, are available from Components For Research Inc. Having no internal voids to be filled with oil, they can be mounted in any position.

Model M-1003 is capable of corona-free operation at 40 kv and ha a peak pulse operating level of greate than 70 kv for air-to-oil, or 140 k oil-to-oil, operation. Flashover is 6 kv positive DC.

Epoxy construction also contribute a thermal-shock resistance range fror −60 to +175°F, the small over-a length of 5 in., and the low weigh of 16 oz.

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Air Conditioning Unit

A compact, high-capacity air conditioning unit, designed for integral mounting in electronic racks, is available from Ellis and Watts Products, Inc.

The Model RBM100 cooler provides automatic removal of condensate, requiring no drain line. All motors operate continuously to eliminate voltage fluctuations. Supply air temperature is controlled with an adjustable, hot-gas by-pass regulating valve. Provision is made for either vertical or horizontal supply air discharge—changeable in the field.

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Valve Operation Analyzer

An automatic device for the exact measurement of time intervals in sequential operations of solenoid or relay-actuated components or systems has been introduced by Consolidated Avionics Corp. The unit also provides "position-versus-time" plots for such operations as linear or non-linear valve motion.

Known as a Valve Operation Analyzer the unit measures time interval as short as 0.1 millisecond and presents the readings visually. As many a 12 sequential events occurring within three-second time span can be automatically timed.

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Co. A double-table arrangement allows setting angles to quarter degrees with accuracy of ¼ second of arc. Useful for either inspection or machining, the table eliminates gage blocks and permits unskilled operator to quickly set and reproduce any angle in increments of 15 minutes.

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Solid-State Commutator

A solid-state switching device, available from Electronic Systems Development Corp., samples data from multiple sources on a time-sharing basis. Output can be applied to a single input of recording equipment, indicating equipment or data transmitting link such as a single telemetry sub-carrier channel.

The "Series ES/35" unit is supplied in standard scan rates of up to 25 KC, and different models can accommodate from 2 to 100 channels. Linearity is within ±0.1% deviation from straight line; contact resistance 25 ohms max.

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RF Frequency Voltmeter

An RF millivoltmeter which measures RF voltages from 1 millivolt to 10 volts at frequencies up to 1,000 MC is available from Hewlett-Packard Co. Readings are virtually free from the temperature effects normally associated with sensitive RF meters. Model 411A is compact and includes two linear voltage scales in a 1:3 ratio.

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Printed Circuit Connectors

The Electronics Division of DeJur-Amsco Corp. has available a series of printed circuit continental connectors with beryllium copper contacts.

Designated Series 600-120, these

Propellant Briefs from Callery Chemical Company

NITRONIUM PERCHLORATE (NO_2ClO_4) New Solid Oxidizer is now available for testing purposes from Callery's laboratory scale production unit for use in propellant development. Large scale production is practical and efforts are under way to expedite rapid development of this capability.

Nitronium perchlorate if pure and properly handled is not shock sensitive. It is hygroscopic and must be handled accordingly. The bulk density of the production material is low, but can be increased by pressing to a density near that of the crystal density—2.22 g/cc. This will overcome some of the handling difficulties which may occur with the fine light material.

Callery has stored a sample of nitronium perchlorate for six years with very little reduction in purity.

Nitronium perchlorate is proving useful in solid and hybrid rocket systems and in explosives. It can be used as a nitrating agent and possibly as an intermediate in other chemical syntheses.

Write for Bulletin C-1200.

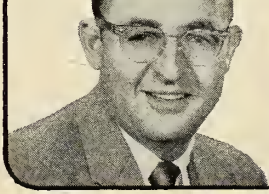
PENTABORANE (B_5H_9) Performance Data—Potential of pentaborane as a fuel is evident in its high heat of combustion—29,000 Btu/lb.— and its high specific impulse. Recent calculations yield the following shifting-equilibrium impulses for pentaborane:

Oxidizer	I_s 1000/14.7 psia	I_s 1000/.2 psia
OF_2	367	466
F_2	360	460
O_2	327	421
NF_3	326	413
H_2O_2	316	399
ClO_3F	306	391
N_2O_4	306	390
NO_2ClO_4	302	389

Pentaborane is compatible with all common metals, Saran, polyethylene, Kel-F, Viton A, asbestos, and graphite.

Write for Bulletin—Pentaborane C-1300.

For information or technical service: write Defense Products Dept., Callery Chemical Company, P.O. Box 11145, Pittsburgh 37, Penna.



Mr. J. R. Perrin
Manager, Western District
17618 Ventura Blvd.
Encino, California

CALLERY
CALLERY CHEMICAL COMPANY

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units have dual terminations and bifurcated "Bellowform" contacts for 1/16 in. printed circuit board or tape cable. They are available in 6, 10, 15, 18, 22, 28, 43, 48, 58 and 105 dual contact sizes (or an equivalent of 12 through 210 terminals), and a choice of three mounting styles.

Circle No. 231 on Subscriber Service Card.

Numerical Control

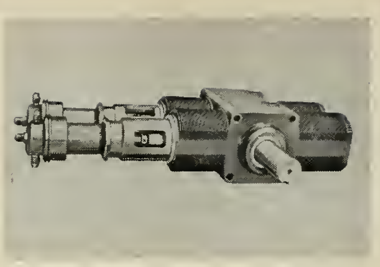
General Electric is marketing a numerical control system for metalworking machines which will make punched-tape programming as simple and economical for contouring operations as for standard positioning.

Modular, compact design of the control will simplify both installation and maintenance. All electrical circuits incorporate printed circuit boards in plug-in modules, instantaneously removable for easier maintenance.

Circle No. 232 on Subscriber Service Card.

Lightweight LOX Pump

A high-pressure pump for low boiling point liquefied gases, such as argon, oxygen, nitrogen and liquid hydrogen is available from Paul Chemical Co. Tipping the scales at 30 lbs., the pump provides the same standards of performance and reliability as high-pressure pumps designed for equivalent work loads, but weighing up to 900 lbs. The need for external support equipment such as lubrication pump, filter and reservoir, cooler, fan, etc., has been eliminated.



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Strain Gage with Readout

Statham Instruments, Inc. has introduced a resistance strain gage, Model SG2, with a complementing portable bridge control readout, Model BCR1-O.

The Model SG-2 resistance strain gage is designed for repetitive measurement of strain or unit elongation. It incorporates the Statham zero-length unbonded strain gage, and has strain or elongation sensed between two fixed knife edges and one movable knife edge.

Circle No. 234 on Subscriber Service Card.

new literature

T & P CONTROLLERS—A 6-page Catalog J-C describes the pneumatic pressure and temperature controllers available from OPW-Jordan. The brochure describes features and accessories, and gives dimensions, specifications, materials of construction and complete engineering information.

Circle No. 200 on Subscriber Service Card.

UNITIZED CHECK WEIGHING SYSTEMS—A bulletin on check-weighing systems has been published by Weighing & Controls, Inc. The systems covered in the bulletin can be applied to all types of dry or liquid, single- or multi-unit containers to provide a continuous check on the filling accuracy of packaging equipment.

Circle No. 201 on Subscriber Service Card.

METAL PROCESSING—Phoenixspun Powerspinning, a new development in metal processing is described in a bulletin published by the Metal Spinning Division of Phoenix Products Co. The Phoenixspun method makes possible the economical and highly accurate spinning of even the toughest alloys . . . chrome-moly steels, the stainless steel alloys, titanium, high-strength aluminum alloys, etc., in thicknesses up to 2 in. and diameters of 170 in.

Circle No. 202 on Subscriber Service Card.

BROACHING MACHINES—A 6-page brochure issued by the Foote-Burt Co. describes their line of continuous horizontal surface broaching and vertical surface-broaching machines. The bulletin illustrates a number of typical parts produced more rapidly and economically by broaching than by any other method.

Circle No. 203 on Subscriber Service Card.

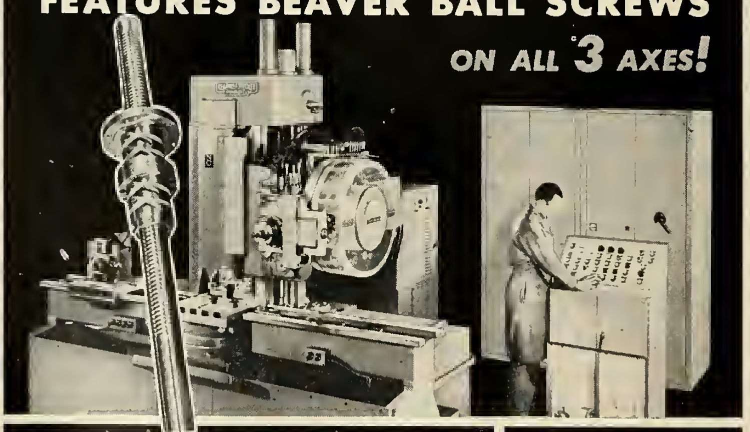
DATA DIGEST—Laboratory for Electronics, Inc., has published a new Technical Data Digest describing the company's capabilities in airborne doppler navigation systems. The eight-page, illustrated brochure details specifications of these equipments, including system philosophy, operational capabilities and performance, and various models of the Doppler Navigators produced.

Circle No. 204 on Subscriber Service Card.

STEEL CASTINGS — Lebanon Steel Foundry has published a bulletin on precision steel castings, produced in ceramic molds. The bulletin describes the relative advantages of process and illustrates examples and applications.

Circle No. 205 on Subscriber Service Card.

K & T'S MILWAUKEE-MATIC
TAPE-CONTROLLED MACHINING CENTER
FEATURES BEAVER BALL SCREWS
ON ALL 3 AXES!



A significant machine tool achievement—Milwaukee-matic numerically controls positioning, tool selection, indexing, machining, speeds and feeds. Preloaded Beaver Ball Screws with the inherent precision, essential in data control, were the choice of Kearney & Trecker designers for spindle positioning, cross feed and table feed—just as they are with most builders of numerically controlled machines.

Our engineers will be glad to work with you.

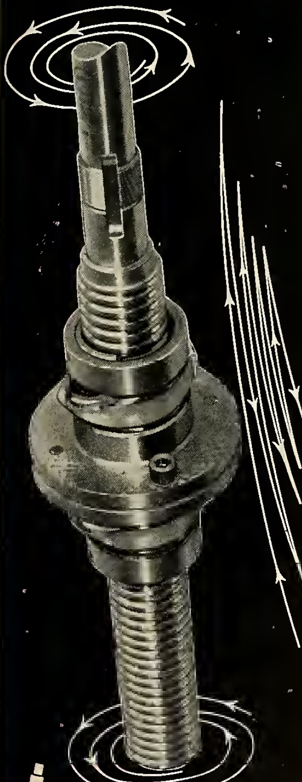
Beaver Precision Products INC.
CLAWSON, MICH.

Circle No. 30 on Subscriber Service Card.

BEAVER BALL SCREWS

Successor to the Acme screw drive and preferred in many applications to hydraulic and pneumatic systems. Guaranteed 90% efficient in converting rotary twist to linear push (or vice versa). Employs a stream of precision balls and ground lead to eliminate drag and wear in delicate instruments, aircraft, machine tools, massive wind tunnel jacks, etc. For horizontal and vertical actions, indexing, inching and traversing. Consultation and engineering service available. Write for literature.

EXTREME ACCURATE POSITIONING • NO BACKLASH • RAPID START • ANY DIAMETER OR TRAVEL •



Beaver Precision Products INC.
CLAWSON, MICH.

Circle No. 31 on Subscriber Service Card.

Re-entry Drag Devices

(Continued from page 48)

able as yarns suitable for the flexibility requirements. However, low rupture elongation and sensitivity to abrasive damage make this material difficult to fabricate and may well interfere with compactibility. Graphite cloths, leached glass cloths, non-woven and woven staple fibers of a variety of oxides are also available. But these also tend to suffer from friability, and low flex and abrasion resistance.

The list of potentially useful materials is growing. Many of the new alloys, fiberized ceramic materials or graphitic fibers could be the ideal material, provided suitable structural designs and fabrication techniques are developed. "Whiskers" seem to be naturally adaptable for the job, but quantity production represents a considerable problem.

Research is continuing but is still some distance from developing the ideal material for expandable drag devices. The additional problems of fabricating the material into a structure (joints, seams, hinges, etc.) has also to be tackled. Intensive effort is required in both areas. ⁂

—when and where—

DECEMBER

IRE Professional Group on Vehicular Communications, Sheraton Hotel, Philadelphia, Dec. 1-2.

American Institute of Chemical Engineers, Statler Hotel, Washington, D.C., Dec. 4-7.

Electronics Industries Association, Third Conference on Maintainability of Electronic Equipment, Hilton Hotel, San Antonio, Tex., Dec. 5-7.

ARS Annual Meeting and Astronautical Exposition, Shoreham Hotel, Washington, D.C., Dec. 5-8.

National Conference on the Application of Electrical Insulation, Conrad Hilton Hotel, Chicago, Dec. 5-8.

American Nuclear Society, Mark Hopkins Hotel, San Francisco, Dec. 11-14.

International Scientific Radio Union (URSI), IRE Fall Meeting, NBS Boulder Labs, Boulder, Colo., Dec. 12-14.

Industrial Building Exposition and Congress, Coliseum, New York City, Dec. 12-15.

Annual Eastern Joint Computer Conference, Hotel New Yorker and Manhattan Center, New York City, Dec. 13-15.

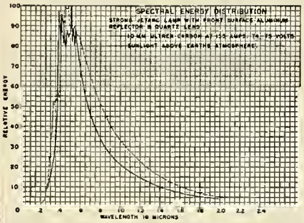
Atomic Industrial Forum, Annual Conference, Fairmont Hotel, San Francisco, Dec. 14-16.

Institute of the Aeronautical Sciences, Wright Brothers Lecture, Smithsonian Institution, Washington, D.C., Dec. 17.

Strong SOLAR RADIATION SIMULATOR

The Strong blown type Jetarc, the most powerful carbon arc, has proved to be the best artificial simulator of solar energy in the development and testing of space vehicle components.

Useful radiation is efficiently collected by first surface reflectors and concentrated at the reimaging point from where it can be projected by a quartz objective system in a pattern shaped to fit the work area. A circular radiation pattern totals 374 watts with an 80% uniformity of field or a total of 668 watts with a 60% uniformity of field. Higher or lower energy unit areas, can be obtained by variation in optics or projection distance. Large areas can be covered by multiple employment of lamps using either superimposed or overlapping pattern technique. Other, less powerful carbon arc sources, are also available for smaller work areas.



A continuous spectrum is available from .25 to 5.+ microns, with the spectral energy distribution very close to solar energy distribution above the earth's atmosphere.

The Jetarc source can be oriented in any plane without loss of stability.

You are invited to consult with Strong Electric on your particular problems.

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387 CITY PARK AVE. • TOLEDO 1, OHIO

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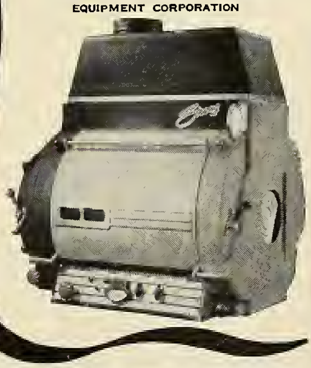

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Energy Technology
At
THOMPSON
RAMO WOOLDRIDGE
INC.

In the development of advanced energy technology, efforts at Thompson Ramo Wooldridge encompass energy conversion, regulation, inversion and control. Research and development is currently in progress on:

- Solar Turboelectric Space Power
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- Underwater Propulsion
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- Integrated Environmental Control Systems
- Vehicle Atmospheric Control
- Closed Cycle Oxygen Regeneration

Selected assignments are available now in analytical and experimental heat transfer, fluid dynamics; liquid metal and gas bearing research, turbomachinery analysis, plasma physics and electrochemistry.

Scientists and engineers with unusual capabilities are invited to investigate positions at Thompson Ramo Wooldridge Inc. For additional information, write informally or forward your resumé in confidence to Mr. James Panoska.

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Dept. No. MR-11-28
7209 Platt Ave.
Cleveland 4, Ohio

names in the news

WEHRLI

SCHIFF

STONE

Robert L. Wehrli: Vice president and general manager of Robertshaw-Fulton's Aeronautical and Instrument Division moves to Richmond about Jan. 1 as vice president and assistant to the president. **Raymond H. Heller,** director of field engineering and sales, moves up as general manager of the Aeronautical and Instrument Div., effective immediately.

Dr. George K. Chacko: Former operations research analyst for Atlas Powder Co., appointed manager of operations research for the Semi-conductor Division of Hughes Aircraft Co.

Donald E. Sweet: Senior engineer at the Electronic Engineering Co. of California, named staff engineer. Prior to joining the firm in 1956, he was an instructor in *Nike* computer operations at the Army's Redstone Arsenal.

Harry L. Stamm: Selected as manager of applications engineering section for the Trimpot Division of Bourns, Inc. Stamm and his staff of six application engineers will be responsible for technical liaison with sales engineers and customers.

Robert Poet: Appointed general sales manager of Telecomputing Corp.'s Narmco Industries' Materials Division, in charge of sales and marketing activities.

Hans M. Schiff: Joins Packard Bell Electronics Corp. as general manager of the Technical Products Division, succeeding **Richard B. Leng,** who earlier this year was named group vice president of the Defense and Industrial Group. Schiff was formerly operations manager of Ryan Aeronautical Co.'s electronics division.

Robert L. Eichberg: Former assistant to the president of Avco Corp.'s Research and Advanced Development Corp., joins Stromberg-Carlson's Electronics Div. as system program manager.

James C. Smith, Jr.: Elected director of Chrysler Corp.'s Advanced Projects Organization. He joined the company in 1956 as chief engineer of Marine Missile Systems and in 1957 was named Missile Division's chief project engineer in charge of engineering program management of the *Redstone* and *Jupiter* missile systems.

Dr. Ralph P. Ruth: Former projec physicist at the Bendix Corp., appointe senior scientist at the Hoffman Scienc Center, Hoffman Electronics Corp.

Richard L. Stone: Named manager sales for the General Electric Special Programs Section in Radnor, Pa. Was formerly an advanced program plannin specialist for the section and prior to tha project engineer with the company's Missile and Space Vehicle Dept. assigned t ICBM and IRBM nose cone development

Jackson Dies in Crash

Col. Nelson P. (Pete) Jackson (USAF-ret.), President and one of the founders of the National Rocket Club was killed on Nov. 13, when the light plane he was piloting crashed into Spruce Knob, southeast of Elkins, W Va.

Mr. Jackson, who was manager of Joy Manufacturing Co.'s Washington office, was on his way to the firm's New Philadelphia, Ohio, plant. Prior to joining Joy, he handled nuclear activities in Washington for the General Electric Co. A West Point graduate, he commanded the 64th Fighter Wing during World War II, and was awarded 19 decorations.

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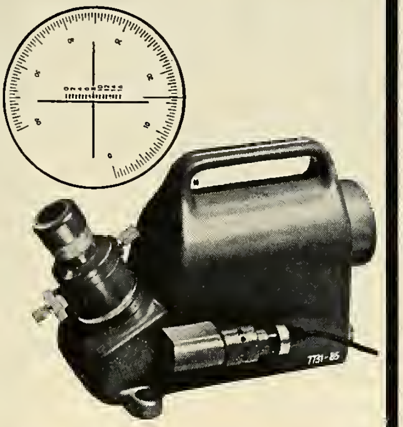
- For checking angular deviations within 1/10 second of arc over an expanded range of 30 minutes.
- Short and compact design of 13" overall length, retaining 20" focal length by folded beam.
- 2¼" aperture of objective.
- Measurements in 2 planes by merely rotating eyepiece 90°.
- Range of focus 0-50 feet.
- Large assortment of accessories.
- Request catalog 85-3.



OPTO-METRIC TOOLS, INC.
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Meetings in Europe Affect U.S. Defense

STRANGELY ENOUGH, many of the events which will greatly affect and help to shape U.S. foreign and military policies for the next four years of the Kennedy Administration are now being worked out in Europe.

Directly or indirectly, these events will have a strong bearing on American spending abroad, for arms and other commodities. They will affect our Congressional attitude on sharing nuclear secrets, and even affect any revision of the Atomic Energy Law. They concern our association with NATO and other European international organizations.

Last week Secretary of Treasury Robert B. Anderson and Under Secretary of State Douglas Dillon visited Bonn to confer with Chancellor Adenauer. Object: to persuade Adenauer to increase Germany's contribution to joint defense—and thus decrease ours.

The old Organization for European Economic Cooperation, which has quietly occupied the Chateau Muette on the edge of the Bois de Boulogne in Paris since the advent of the Marshall Plan, is being changed to the Organization for Economic Cooperation and Development.

The U.S. was an associate member of the OEEC. We will be a full member of the new OECD (17 European members, Iceland, Canada and the U.S.). Object: to cooperate on general economic and business policies, expand aid to undeveloped countries and expand trade generally.

One of the men sent to see Adenauer—Douglas Dillon—is also the father of OEDC. He is being mentioned for a post in the Kennedy government, possibly as Secretary of Treasury.

On December 5, France, West Germany, Italy, Belgium, the Netherlands and Luxembourg will meet in Paris for a "little summit." Object: to consider establishing their own mutual defense grouping outside NATO.

These are the six nations associated in the Common Market. De Gaulle advocates establishing national forces on an integrated plan as opposed to integrated forces under NATO. Adenauer opposes. The U.S., although not participating, will watch it closely—because if the De Gaulle sentiment carries it could seriously undermine or destroy NATO.

On November 26, a group from the Joint Senate-House Committee on Atomic Energy was to leave for an inspection tour of U.S. military installations in Europe. Object: to determine if the present handling of nuclear weapons abroad is within the spirit and intent of the Atomic Energy Law. Their findings will inevitably affect their attitude toward any request to amend the measure if there is a move to provide nuclear arms to NATO.

Vice President-elect Lyndon B. Johnson headed up a Congressional group which went to Paris for a NATO Parliamentarians Conference opening last week. In the Johnson party was William Fulbright, the Democratic Senator from Arkansas who has been prominently mentioned to fill the post of Secretary of State. While this Conference has no concrete authority, it obviously has tremendous influence.

And, on December 16, the Foreign and Defense Ministers of NATO will meet in Paris. Object: to conduct the annual review of NATO and to consider a proposed 10-year plan and such opposing matters as nuclear arms for NATO, adoption of the *Polaris* (or some other missile) and—world arms reduction.

THERE HAS BEEN a great deal of early consultation between officials of the old Administration and liaison appointees of the new. It is obvious, however, that the Eisenhower representatives will be able to commit the new administration to few if any important decisions. Nor would the other nations accept such interregnum answers as binding.

Nevertheless, these events in Europe, now and for the next few weeks, cannot help but have a great influence on the decisions facing the Kennedy Administration. They will affect the U.S. citizen in such odd and varied ways as: Will the service wife accompany her military husband overseas? Where will *Polaris* submarines be based? How greatly should the defense and space program be accelerated? They could even determine the size of the draft and U.S. industrial employment.

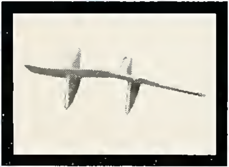
They are interesting events to watch.

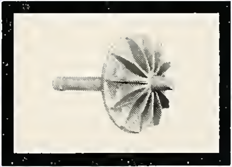
Clarke Newlon

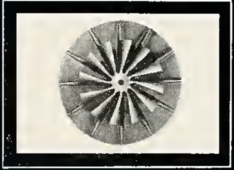
CREATING NEW DIMENSIONS IN METALWORKING

FORGINGS BY ARCTURUS

Using highly advanced techniques, Arcturus is creating precision forgings that pace our expanding technology...forging difficult configurations to meet the most critical industrial and military requirements. Arcturus solutions to your metalworking problems will meet your design criteria, drastically reduce machining time, increase the strength of the finished part. Our 25,000 pound steam drop hammer is the largest in the west—we work with most metals and high temperature alloys. The next time you have a critical metalworking problem—from a thin walled turbine wheel to an industrial fitting—investigate the forging capabilities of Arcturus. Write for our brochure, Forging Ahead With Arcturus.







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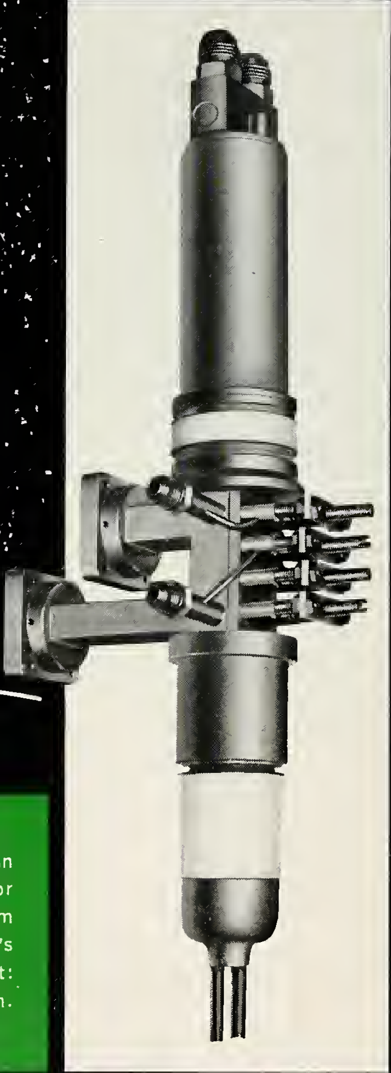
20kW CW at X-band



It's likely that Varian can provide a solution for your particular system design problem. There's a good way to find out: write Tube Division.

Varian's new VA-849 amplifier klystrons are rated to deliver higher CW power at X-band than any existing tube in the world . . . 20kW!

Varian's new VA-849 power klystron opens up a variety of new design approaches to space systems. Possible applications exist in communication concepts such as repeater satellites, moon-bounce signalling, or in reflections from clouds of tiny orbiting needles. Radio astronomers, too, will welcome the VA-849.

Immediate applications include CW radar and illuminator service. Low incidental noise. Water cooling. Electromagnet focusing. Another significant advance In microwave components from Varian's broad experience and research in super-power tubes.

FEATURES

- **7.125 to 8.5 kMc**
- **20 kW CW**
- **50 db Gain.**
- **30 Mc Minimum Bandwidth**
- **Tunable 60 Mc.**

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DECEMBER 5, 1960

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NTERVIEW WITH AF'S WILSON—

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AN AMERICAN AVIATION PUBLICATION

BIG GYRO PERFORMANCE IN...
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FN30 SERIES* NON-FLOATED MINIATURE FREE GYRO
FM10 SERIES* NON-FLOATED MINIATURE FREE GYRO
FOR TARGET DRONES
VA10 SERIES* AIR ERECTED MINIATURE VERTICAL GYRO

THE SMALLEST GYRO PACKAGES AVAILABLE

*PATENTS APPLIED FOR

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For free gyro application, choose either the *torqueable* FM10 Series or the *cageable* FN30 Series. Both offer low drift rate . . . high vibration resistance . . . and big gyro performance through the use of a low gimbal inertia to a high angular momentum ratio.

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These new gyro series are further proof of Daystrom's ability to create better airborne instruments and systems in smaller, more economical packages for military and commercial use.

Openings exist for qualified engineers

FEATURES:

FN30 Miniature, non-floated, cageable, two-axis free gyro with either A.C. or D.C. motor and either (1) outer gimbal synchro pickoff (2) potentiometer pickoffs on both axes or (3) potentiometer pickoff on inner gimbal and synchro pickoff on outer gimbal.

FM10 Miniature, non-floated, two-axis free gyro with synchro pickoffs and torquers on both gimbal axes.

VA10 Miniature, non-floated, air erected vertical gyro with potentiometer pickoffs on both axes. Verticality — operating or non operating — without separate caging mechanism insures (1) greater inherent reliability (2) simplicity of operation (3) lower cost (4) smaller size and (5) less weight.

For complete information and specifications, write for Data File MR-1162-2.

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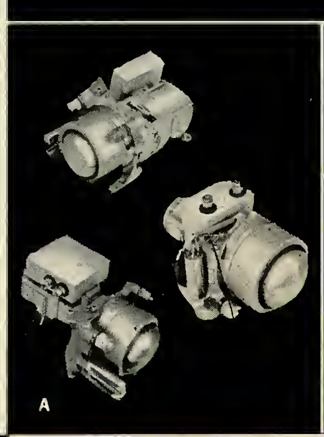
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missiles and rockets

Volume 7, No. 23 December 5, 1960

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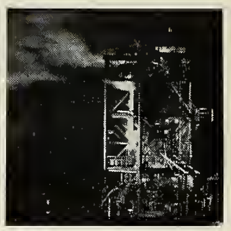
THE COVER

Special test rig at Point Loma, near San Diego used by Convair for cold flow tests of heavy-walled second stage tank for liquid hydrogen system of Centaur. See p. 38.



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*U.S. Reg.
†U.S. Reg. Pdg.

32,794 copies this issue

Engineering notes from the **SM/I REPORTER**

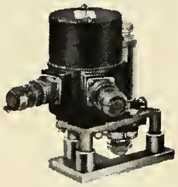
BY STANLEY M. INGERSOLL, *Capabilities Engineer*

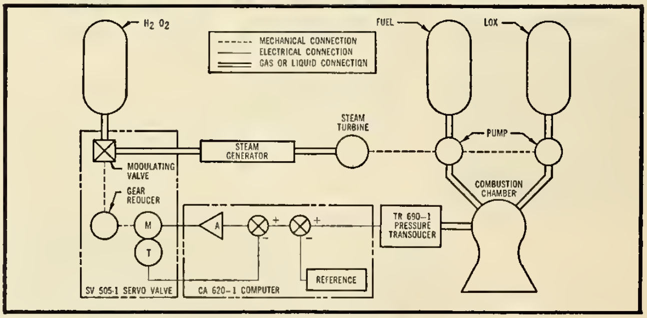
Report No. 13
Type CC 506 Thrust Control System

Designed for tactical artillery weapons, this system maintains the thrust levels of liquid propellant rocket engines at specified magnitudes. Its sensitive SM/I-designed pressure transducer measures combustion chamber pressure and is statically and dynamically accurate even in the extreme shock and vibration environments of the missile. When the transducer detects a deviation from the pre-set reference pressure, it generates an error signal. This signal is amplified and transmitted to a servo controlled valve which restores the pressure to the proper setting. The amplitude of the signal is proportionate to the magnitude of pressure change. Heart of the transducer is a unique, SM/I-developed twisted Bourdon tube that combines high pressure sensitivity (rotational movement) and low acceleration and vibrational sensitivity (linear movement). A 300 PSI unit has only a .2% error under 15 g's vibration and 10 g's acceleration and withstands 20 g's shock without disturbing its setting.

Typical Technical Data

Temperature	—65° to +165°F
Vibration	10-38 cps ±0.25" Double Amplitude. 38 to 2000 cps ±25 g's
Shock	50 g's
Altitude	Sea Level to 200,000 ft.
Weight	10 pounds
Input Voltage	115 volts 400 cycles
Accuracy	better than 1% of the pressure
Valve Flow Rate	30 lb/min H_2O_2
Magnitude of Set Pressure	300-1000 psi
Slewing Speed of Valve	2-3 seconds





For more information and complete operating specifications, write or wire SM/I today. Address your inquiry to Stanley M. Ingersoll, Capabilities Engineer.

SM/I

SERVOMECHANISMS/INC.
Los Angeles Division
200 Aviation Boulevard
El Segundo, California

—letters—

On Space Photography

To the Editor:

I read, with great interest, your editorials. On account of my early connection with the Guided Missile program, I find it helps to keep me up to date on this important segment of our scientific developments for our services.

Your editorial of Nov. 7 ("Samos—and What Happens Then?") raises the question of space photography. For me, it is still simple. Traditionally, we have allowed photographers to break down privacy. Always, somewhere around, there seems to be someone with a flash camera who shows up and takes pictures of individuals at the most unsuspecting moments. Those who take them think they have the privilege, and about the only defense the individual has is, if the man is close enough, to kick the camera or smash it up; then you are a nasty aggressor and unsocial, because you are denying, to the curious, certain assumed privileges. In reality, these privileges are really the privilege of the photographer making his living and the newspapers making their product more desirable to more and more readers.

With the tremendous developments in photography and the long range at which pictures can be taken, you get into technical question of how much space belongs to the separate and national boundaries. You can take quite a number of pictures in Russia without being technically over Russia. It therefore seems to me that this international problem is not going to be solved on technical grounds. It will be only a short time, relatively speaking, until hardware will be developed that will shoot down satellites or make them inoperative. Then the problem will be, "How will you control your retaliatory hardware so that it does not bring down a satellite that is technically above some geographic location other than the boundaries of the nation shooting it down?" Therefore it seems to me that this is not going to be solved by words. And here again, the advantage is going to go to those who are technically- and hardware-equipped to best exploit this field.

K. T. Keller
Detroit

Pye and Spadeadam

To the Editor:

I have read your article on "Britain's Big Rocket Test Centre" (M/R, Sept. 19, p. 52) and think that, in general, it is a very good article.

I consider, however, that you have not done full justice to the contribution made by my Company to this project. You do say on page 54 that "The control room for this Site has been instrumented by Pye Ltd.," but that is all. In fact, my Company was one of the major sub-contractors on this project and was responsible for the whole of the instrumentation of the Site,

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ıt only of the Engine Control Room.

I trust that you will not mind my ›inting this out to you. It is quite possi-y our fault for not having advertised ır wares previously, but this has been ıe to security restrictions.

T. Dorricott, Project Mgr.
Spadeadam Group, Pye Ltd.
Cambridge, England

ı/R 'Gaffes'

› *the Editor:*

Permit me to make one remark re-rding the story "MATRA-Mirage: An ll-French System" (M/R, Sept. 26, p.).

You state that the air-to-air *R. 530* obably has thrust/guidance control un-ce the *Falcon*. Our missile has aerodyna-ic controls like its predecessor, the *R. 1.*

As for tactical aircraft equipment, our ımpany manufactures most of the air-unched free-flight rockets used by the ench forces.

R. Robert, Technical Director
Engins Matra
Boulogne, France

› *the Editor:*

We are always pleased to have our oducts appear within the covers of ISSILES AND ROCKETS. We are particu-rly pleased when our products are ident-d as such, rather than as the products some other company, something which curred on page 24 of M/R, Oct. 10. e *5103* is Nord's and not Matra's. At st this was the position you took in a cent issue when you did a very excellent ticle on the *5103*.

Donald G. Agger, Director
American Office
Nord-Aviation S.A.
Washington

yna-Soar Propulsion

the Editor:

I wish to call your attention to an consistency in your November, 1960, strolog. The *Dyna-Soar I* propulsion ntractor is listed as The Martin Com-ıny. Since the description for the *Dyna-ıar I* lists the booster as a *Titan I*, the opulsion contractor should be Aerojet-eneral, as you have correctly listed for *tan I*. The Aerojet-General Corporation ill supply man-rated propulsion systems r the Air Force *Dyna-Soar* "man in ace" program.

W. G. Cowdin
Technical Program Manager
Dyna-Soar Program
Aerojet-General Corp.
Sacramento, Calif.

M/R intended no slight regarding erojet-General's work on the Dyna-ar program. The R&D contract ar-ngements for Dyna-Soar I call for using tan I as the booster. Since The Martin ı. is prime contractor for the Titan I issile, it is in this sense the propulsion ntractor for Dyna-Soar I.—Ed.

Space Electronics Corporation creates and constructs a wide variety of advanced electronic systems for the nation's missile and space programs. SEC is now responsible for fabricating the airborne and ground-based electronic systems for the USAF's most recent space booster. In its first flight relying on SEC electronic systems, it launched into successful orbit Courier 1B — the world's first active-repeater communications satellite. The booster:

AbleStar

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Qualified scientists and engineers are urged to direct their inquiries to the personal attention of Dr. James Fletcher, president.

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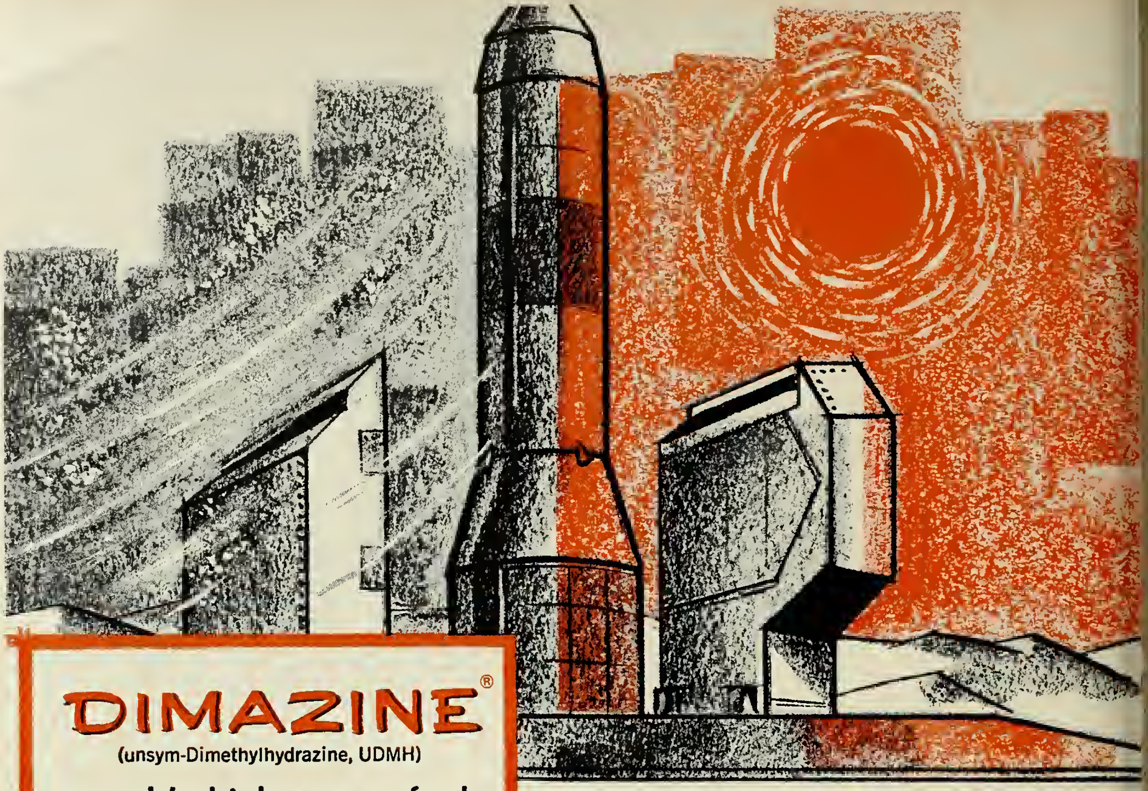

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The Countdown

WASHINGTON

Smoke Along the E-Ring

Whatever rejuggling takes place in the Pentagon under the new administration, the Army and the Navy can be expected to remain "allies" against the Air Force. They are sticking together in hopes of getting a bigger percentage of the DOD budget for limited war. First show of strength could come over the Navy's bid for more *Polaris* subs faster and the Army's bid for *Pershing II.*

Squeeze on Weather Satellite

Countdown hears the Eisenhower Budget Bureau is allowing the Weather Bureau to request just $2.2 million in FY '62 for R&D in using satellite weather information. It also is being allowed a $1 million downpayment for a special communications net. This is $300,000 less than the bureau wants for R&D and $1.5 million under its communications requirement. But the picture could change in a Kennedy supplemental budget.

Whither Defender?

Insiders tell Countdown that ARPA's Project *Defender* may need several more years—at least—to gather sufficient data for development of an advanced antimissile system. The present *Defender* budget is running about $130 million.

Shillelagh Still Swinging—Slowly

The Army is still keeping the wraps tightly wound around the R&D program aimed at bringing forth the lightweight *Shillelagh* missile. (So secret is this bird, that the Army isn't even saying what it is for. Best guess: anti-personnel). It is understood that one of the problems in pushing the program along may be money. And the Army would like to give it a shot of funding.

Pickering for Dryden?

Government transition watchers are placing bets that Dr. William H. Pickering, JPL director, will get the job of Dr. Hugh L. Dryden, who will retire in January as NASA deputy director.

Saipan 'Fence'

There's word that the whole north portion of Saipan is being fenced off by the U.S. Reason: possibly to build a Navy ULF radio station for communicating with Pacific-based *Polaris* submarines.

Resuming Nuclear Tests?

Diplomatic circles are buzzing with reports that the U.S. will drop its nuclear test ban soon after Kennedy takes office. The British are said to be so certain of this that they are already preparing another series of tests on Christmas Island in the Pacific. Presumably they would be firing bigger weapons than those now in stock.

Beacons in the Deep

Some Navymen are pretty certain Soviet hydrographic expeditions are laying short-range (about 1 mile) radio beacons on the ocean floor. Beacons would be used by missile-equipped Red subs to home in launch positions without the need for *Polaris*-type inertial navigation.

INDUSTRY

Reviving Renegotiation

Industry has until Dec. 15 to submit suggestions for improving the Renegotiation Act to the Joint Internal Revenues Taxation Committee. The Committee expects to include the suggestions in a report to Congress next March 31. The recommendations should avoid the procurement area which is being handled by the Armed Services Committees.

Titan Bugged

Launch of the first *Titan* at Vandenberg AFB from a silo configuration, originally set for this month, has now slipped several weeks. GSE reportedly has developed electronic bugs which caused the shot to be removed from the launch schedule.

Base Building Speeds Up

Army Engineers report time lost through strikes on ICBM base construction sites dropped 30% in the six months ending Oct. 31. They expect further improvement in the current period. Several more *Atlas* pads are expected to be turned over to SAC in the next few months.

Sonar Proficiency Down

Navy recently tested 400 Pacific fleet sonarmen and came up with this disturbing report: "On the average, ability of sonarmen to operate electronic test equipment. . . . was poorer than desirable." Efforts are now underway to raise proficiency.

INTERNATIONAL

Secret British Missile

Reports are circulating in London of a new British air-to-ground missile which can fly at treetop height. The secret bird is said to be intended for the RAF's new bomber, the TSR 2, which is designed for land "contour" flying to get under enemy radar.

Firestreaks Score 80% Hits

In first full-scale training firings from Sea Vixen aircraft, the British Navy's air-to-air *Firestreak* is reported to have scored 80% successes against target aircraft. The Defense Ministry is said to be pleased.

Overseas Pipeline

Dr. Theodore von Karman is the first director of the newly formed International Academy of Astronautics, headquartered in Paris . . . Japan's Defense Ministry is earmarking $2.2 million for lead production of 11 different missiles (a total of 1217 rounds) most of them air-to-air . . . and Swedish Prof. Torbnjoern Caspersson reveals the invention of a microspectograph which he believes may be able to determine whether life exists on other planets.

Soviet View of Polaris

A Russian Water transport newspaper, *Vodnii Transport*, in a two-part series has reported details of the *Polaris* system. Most significant items: *Polaris* missiles are launched while the sub is "at a depth of 25 to 30 meters" and ignite "20 to 25 meters above the sea's surface"; U.S. nuclear submarines "stay under 95-98% of the time with speeds up to 30 knots instead of 10 knots . . . although speeds of 40 to 60 knots are now possible."

OPERATIONAL!

Just 46 months from scratch, the
arms its first Polaris missile subm

The Navy's Fleet Ballistic Missile weapon system is now operational. Somewhere in the seas that cover t
fourths of the earth the USS George Washington is on station, armed with 16 Polaris missiles. Thus
a race against time; thus begins a new hope for peace. Lockheed, prime contractor and missile system
ger, hails Aerojet-General, General Electric, Westinghouse, and the thousands of associated contra
large and small, who helped bring the Polaris missile to operational status.

LOCKHEE

MISSILES & SPACE DIVISION • SUNNYVALE, CALIFO

he Missile/Space Week

AINT Contract Opens Way for Satellite War

The possibility of future satellite wars in space moved a step nearer ality this week with Air Force's selection of RCA to demonstrate the feasi-lity of a satellite rendezvous and inspection system.

The system—unofficially known as *SAINT*—would involve launching tellites capable of determining whether other satellites contained scientific military equipment.

Lt. Gen. Bernard A. Schriever, ARDC commander, said flatly that *SAINT* not "in any sense of the term offensive in character." He said *SAINT* satel-es would "carry no armament and represent no threat to any other nation."

However, it was certain that the Air Force would seek development of a mplementary system to combat any offensive satellites that *SAINT* might scover.

RCA will develop the final stage vehicle and inspection payload for *AINT*. BMD will manage the program. Aerospace Corp. will provide tech-cal supervision. The first launching to test rendezvous techniques is ex-ected within a year.

ATO, 'The Bomb' and the Growing Nuclear Club

The issue of arming the NATO Alliance with nuclear-tipped missiles is ntinuing to claim prime attention in military conferences and debate.

U.S. Military leaders from round the earth gathered at SAC headquarters Nebraska this last week to discuss American military posture—and partic-arly the assignment of strategic targets. High on the agenda: The future le of NATO in the strategic forces of the Free World.

Meantime, Gen. Lauris Norstad, NATO commander, said at Rome that s proposal to make NATO a "fourth atomic power" would not expand the ational membership of the Nuclear Club.

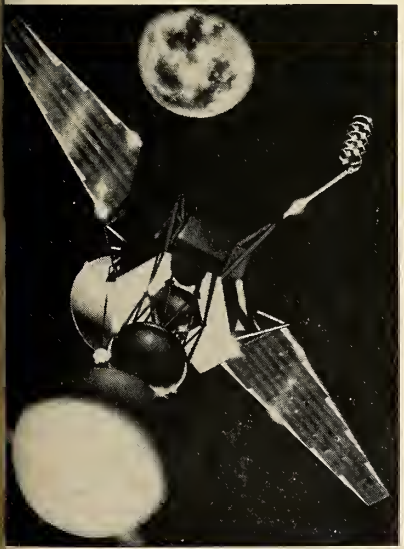
Two days later a Dutch defense spokesman hinted that the Club already s been expanded. He said Holland has a stock of nuclear warheads for e by the Dutch and West German armies. Source: unknown.

ransit Schedule Jolted by Launching Flop

The failure of a *Thor Able-Star* booster to place the Navy's *Transit III A* avigation satellite in orbit last week appears to have at least partly wilted opes of beating the planned 1962 operational date (M/R, Nov. 28, p. 15).

The Nov. 30 launching attempt was a double header. The booster carried oth *Transit III A* and a second smaller satellite as did *Transit II A* last ine. The booster was destructed shortly after take-off.

At present, possibly six more *Transit* satellite launchings are planned in e Navy's R&D program.



Ranger

Final configuration of lunar landing capsule being built for JPL by Ford-Aeronutronic has dumbbell shape. 300-lb. capsule should telemeter data for month after hitting moon.

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. . . hermetically sealed

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Does the U.S. Have 'Second Chance' to Beat Russia?

America is still in a better position than Russia to win military control of space, says AF R&D boss, but 'we have no time at all' to get moving

by James Baar

THE CHIEF OF AIR FORCE R&D said this week the United States must win military control of space or face losing the world to Russia.

The statement by Lt. Gen. Roscoe C. Wilson forcefully underlined one of the coming key defense decisions that confronts the new Kennedy administration.

The question in its simplest terms is: How important is military control of space within the next decade to the security of the United States and the Free World?

The Eisenhower Administration consistently has taken the position that space is of little military importance beyond a few hundred miles out at the very most. President-elect Kennedy sharply disagreed during the election campaign. He said military control of space is of vital importance.

The public argument has generally stopped here. So far, little attention has been paid to the military thinking behind statements advocating a much greater military effort in space.

Here is how General Wilson expressed that thinking in an interview:

"The essence of military supremacy is access," the graying, 55-year-old general said, speaking in the quiet tones of a university scholar. "This made Britain dominant in the Naval Age. This made the United States dominant in the Air Age. It doesn't take much imagination to carry this into the Space Age.

"Russia sits right in the ancient heartland surrounded by buffer states. The only thing that has kept Russia under control is our supremacy in the air. The air alone did this until the missile came along and the missile won't last forever. The means of access to Russia will be aerospace. Turn that around a little and you're looking down at the United States."

Wilson paused and lit a cigarette.

Lt. Gen. Roscoe C. Wilson

IF WE SQUARE while they cube, we've had it.

"Whoever dominates space is going to dominate the earth," he said.

Wilson talked while sitting at his desk in his fourth-floor Pentagon office. He was dressed in a well-cut gray suit. Books were piled on a nearby table and on top of crowded bookcases along one side of the room. All four of the room's softly-shaded blue-green walls were hung with paintings and etchings depicting the exploits of the Air Force in the three great wars of the last fifty years. Behind Wilson stood his red-and-white three-star flag.

"There is no doubt in my mind that the Russians are moving toward control of space as fast as they can," he said. "But in order to do this they are going along a very narrow path. Here is where we have an advantage today.

"The United States is in a much better position to beat Russia to the draw in achieving this kind of capability in space because we have a much wider technological base. And we are generating more new technology than the Russians."

But Wilson emphasized that he believed the present U.S. technical advantage was ephemeral.

"I would say that we have no time at all," he said. If we were to maintain our present pace, we would very shortly be behind. We must accelerate in all our fields at least as fast as Russia—which is exponentially. If we square while they cube, we've had it."

Wilson said a fact many people still do not appreciate is that human knowledge is increasing at a tremendous rate.

"Leonardo da Vinci was the great genius of the Renaissance, he possessed what was then considered universal knowledge," the general said. "Today, Leonardo's knowledge would be considered on about the level of a bright high school senior.

"The knowledge of mankind appears to increase by generations on a curve which is rising exponentially. And, interestingly, it just about matches the curve of population increase."

Wilson grinned.

"Is it our knowledge and brain power or do we imply have more people thinking? I think it is a synhesis. But whatever, the great increases are a fact—and we must keep up. The answer is hard work.

"I myself have little trust in relying on the inventor. The guy who wakes up with a new idea generally is wrong. The true invention really comes from the man who is the heir to all the generations and who has applied himself. By grace of God, we have people working in every field."

• **Propulsion urgent**—Turning to specific U.S. needs, Wilson said "the outstanding area" where the United tates must advance is in the field of propulsion.

"We are limited in everything we do by necessity," e said. "We haven't really begun to exploit all we know bout chemistry. And there is a great field of effort waiting for us in such areas as nuclear propulsion, lasmas and electrical systems.

"However, propulsion is only the outstanding area. We must carry on basic research in every field. We must increase our basic research. We must do a great many hings in applied research.

"The Air Force is spending some $42 million this ear on basic research exclusive of our in-house work. We hope to double this within the next few years. Today e are funding only half of the things we think we hould. But I would hope that by the time we have oubled our money, we would have many new things hat we should begin working on. If you are ever convinced that you are doing everything that needs to be one in research, you are out of progress."

Wilson said the speed with which many of these eeds are fulfilled depends directly on "our ability to ear the expense and industry's ability to reduce the st."

"Here's a pincer movement to get working on," he aid. "It now costs us $1000 to put one pound in orbit. we're going to think about military space systems we must work to get the price down to $100 a pound.

"We must increase reliability. We must improve upport systems. We should make boosters recoverable. his kind of thing will bring down the price. It will take lot of money to do it."

• **Realization**—However, Wilson said he believed hat the United States was coming to realize that the ffort must be made.

"The United States and Russia are engaged in a ruggle that will determine whether the state is going own man or man is going to own the state," he said. This is what is at stake in space.

"The Russians are ahead of us in many areas of pace, but they got there by the accident of developing big booster early. That happy accident gave them a g up and they've exploited it. But because of our chnological advantage we have come along with our issiles and now we have a second chance to go ahead space."

Wilson tapped his desk to emphasize his words.

"If we want tomorrow's world to evolve in the image f our desire, we better by a damn sight take that second chance." ⌘

Scholarly General

ONE OF ROSCOE CHARLES WILSON'S earliest memories of military life is of the day he spent in the guard house at Wyoming's old Ft. Russell when he was about eight years old. He was put there by his father, then an infantry captain, for swiping some .22 ammunition while his father's regiment was on maneuvers.

Today Ft. Russell is Warren AFB, site of three of the nation's first *Atlas* squadrons. Wilson is a lieutenant general and Air Force Deputy Chief of Staff/Development.

The changes both have witnessed in nearly a half a century are almost equally revolutionary.

The tall, soft-spoken general's entire military career has formed a pattern of shifts from operational duty to the classroom to technical staff assignments.

He returned twice to West Point to teach after his graduation in the Class of 1928. He served during World War II with a B-29 wing in the Pacific. He was commandant of the Air War College. He commanded the Third Air Force in Europe in the mid-50's.

Significantly, this scholarly general has geen associated with nuclear weapons since their inception.

During World War II he was the Air Force liaison officer with the Manhattan District. He personally selected the site at Alamogordo for the first atom bomb test. He organized and equipped the unit to send the first A-bombs against Hiroshima and Nagasaki. He was one of the first Americans to inspect the ruins of Hiroshima after the war. And in the late '40's he helped direct further development of nuclear weapons leading toward the H-bomb.

The Air Force named Wilson to his present post in July, 1958. He brought to the job one of the most wide-ranging and literate minds in the Air Force.

The man who passes on all Air Force R&D programs is also highly knowledgeable in such diverse fields as history, English and classic literature and Renaissance art. He has been known to pause at a place like Concord and point out where various Minutemen fell. He can explain in detail the tactics of Marlborough at Waterloo. Elucidate a complicated problem in physics. Discuss the merits of a painting by El Greco or Titian.

Wilson's daily routine sheds much light on his personality.

He assimilates great amounts of information swiftly and makes the most of every moment of the working day. But he never takes a jammed briefcase home to Bolling AFB where he lives with his wife. (His Parkinsonian theory is that the time a job takes always expands to fill the time available.) And he almost always eats lunch alone in his office in order to read a book.

Wilson in civilian clothes could pass for a university president or a diplomat as well as a general. His cordial, literate tones only accentuate the sharpness and military decisiveness of his approach to scientific problems. And his cultured wit serves him well in driving home a point.

Recently one of his favorite quips when speaking about a number of programs has been: "Nunquam facibimus."

"Literally that means 'We will never make it,'" he dryly told some associates. "You might freely translate it: 'You can't get there from here.'" ⌘

Glennan tells Johnson . . .

DOD Okays NASA Repeater Satellite

Space agency will work on lower orbit communications for present; Senate Space Committee report calls for accelerated effort

THE DEPARTMENT OF DEFENSE and the National Aeronautics and Space Administration have agreed that NASA may develop an active repeater communications satellite, a field previously exclusively occupied by the military.

The agreement, between NASA Administrator T. Keith Glennan and Deputy Defense Secretary James H. Douglas, was reached last Aug. 27. Glennan disclosed its existence last week in a reply to an inquiry by Vice President-elect Lyndon B. Johnson, in his capacity as chairman of the Senate Space Committee. The committee released the letter as part of a staff report on space telecommunications problems.

Glennan said NASA will concentrate for the immediate future on communications satellites in orbits ranging in altitudes from 2000 to 6000 miles, while the DOD Project *Advent* concentrates on the 24-hour orbit of 22,300 miles. However, Glennan said NASA's plans and research "will not overlook" the application of 24-hour communications satellite systems to nonmilitary uses.

- **More funding likely**—The NASA administrator indicated a supplemental Fiscal Year 1961 appropriation might be sought to get the project started. But he said the project's timing depends "not only upon fund availability but also upon such factors as vehicle and launch facility availability."

The 2000-6000-mile orbit area passes through the Van Allen belt. Glennan said NASA intends to concentrate in the near future on the effect of radiation on solid-state components such as solar cells.

The space agency chief told Johnson no legislative changes are needed to make it possible for NASA to enter the active repeater satellite field. He said the plan to make vehicles and launch facilities available at cost to industry represents approved policy, but any final action will have to have specific approval before funds are requested.

Johnson asked: "Who will be the judge of whether communication satellite activities of the military are 'well conceived' in deciding whether to duplicate such activities?" Glennan replied that DOD is responsible for military space activities and NASA for non-military. Where there is potential duplication, he said, the issue will be resolved by agreement between the two agencies arranged through the Aeronautics and Astronautics Coordinating Board.

- **Speedup urged**—The Senate committee staff report called for review and possible acceleration of communications satellite research plans, so that results will become available by the end of 1962—in time for consideration at the 1963 Extraordinary Administrative Radio Conference of the International Telecommunications Union.

The report noted that the Department of Defense is investigating active repeater communications satellites through Project *Advent* but added: "It is not clear to what extent such information can be employed by NASA to prevent needless duplication or how much cooperation there will be between these agencies in jointly planning programs to assure achievement of goals promptly, effectively and economically."

Speedup is vital, the report went on, because of the possible opposition by the Soviet bloc to proposals of the United States for increased allocation of frequency channels for space. The Soviet bloc, which controls a large land mass, may be able to obtain the frequencies it needs by readjusting domestic frequencies.

The committee staff also called for thorough study by the Executive Branch of government to determine policy related to:

–Identification of a central federal authority for communications policy.

–Evaluation of policies in the context of space communications.

–Implications with regard to the traditional U.S. practice of assigning communications responsibilities to private commercial interests, rather than the government.

–Mechanism of coordination between government agencies concerned.

–Need for determining the responsibility of NASA for operations in space, rather than research.

NEXT WEEK

In Missiles and Rockets

HOW WILL the Kennedy Administration approach the problem of Civil Defense? Pat Frank, author of the controversial *Alas, Babylon* and other novels, makes a keen analysis of the problem in the Dec. 12 issue. He suggests how the much-neglected Civil Defense Administration could be incorporated into the U.S. deterrent forces -- and why it should be done.

Goal of 270 ICBM Pads Seen Met by End of 1963

PADS FOR 270 *Atlas* and *Titan* ICBM's presently are expected to meet their target completion dates—the last one by the end of 1963.

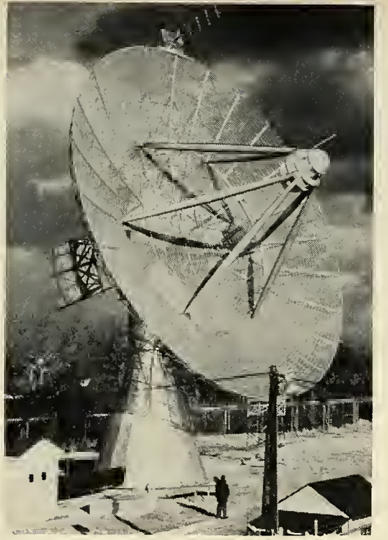
Lt. Gen. Emerson C. Itschner, chief of the Army Corps of Engineers, reported last week that slippage in the $1.2 billion construction program has ended, and building of the complexes is "essentially on time."

Six *Atlas* missiles, all at Warren AFB, Cheyenne, Wyo., are in the hands of operational SAC crews now. Several more pads are expected to be turned over next year, including the first *Titan* nine-missile complex at Lowry AFB, Colo.

The general revealed that at Lowry 300 design changes already have boosted the brick and mortar bill by 60%. Design changes also are responsible for the one-month delay in letting bids for the first 150-*Minuteman* complex at Malmstrom AFB, Mont. Bids were to have been let in November for this base, which has a target completion date of June, 1962 (M/R Oct. 17, p. 29).

Speedup in the program has been effected through a reorganized and streamlined management of the Air Force's AMC and the Corps. Strikes by construction workers have been reduced 30% since May and bottlenecks in delivery of manufactured items also have been cut down, Itschner said. But he said that as long as there are design changes construction costs will rise.

Tiros II Maps Hurt By Poor TV Photos



TIROS II signals are received by 60-ft. dish at Army's Belmar, N.J., station.

by Jay Holmes

WEATHER BUREAU meteorologists began producing Neph analyses (cloud-cover maps) from *Tiros II* pictures last week but the first one was displaced 400 miles to the west.

Their work was hampered by poor quality pictures from the wide-angle television camera aboard the satellite. Narrow-angle pictures were of top quality but they covered such small areas that it was difficult to identify the locations they showed.

Infrared data, needed for basic research into weather processes, was coming in well.

- **Jurisdiction problem**—Meanwhile, a top-level committee agreed that operational use of data from weather satellites would be under complete control of the U.S. Weather Bureau. The question of ultimate control of weather satellite launchings was left up in the air.

The still unresolved question is whether control of satellite launchings should go over from the National Aeronautics and Space Administration to the Weather Bureau when satellite forecasting becomes operational.

At a meeting Nov. 26, NASA Administrator T. Keith Glennan, his deputy, Hugh L. Dryden, Lt. Gen. Donald N. Yates and Chief F. W. Reichelderfer of the Weather Bureau agreed that weather satellites will remain under civilian control and the Weather Bureau will be the operational user of the data. NASA officials maintain that weather satellites are far from operational and that full control must remain for the time being with them as the R&D agency.

- **Mixed returns**—Between the launching Nov. 23 and noon Nov. 28, *Tiros II* transmitted 998 picture frames to the readout stations at the Army's Evans Signal Laboratory in Belmar, N.J., and the Navy's San Nicolas Island, Calif., Pacific Missile Range Station. Of the 312 frames from the narrow-angle camera, 85% are useful. Of the 686 wide-angle frames, 5 to 10% contain some useful information. Corrected orbital elements are: perigee 386.9 statute miles, apogee 453.2 miles, period 98.37 min. and inclination 48.53°.

The satellite's spin rate was increased twice by firing pairs of small Atlantic Research Corp. spin rockets. The first firing, at 9:14 a. m., EST, Nov. 25, increased the spin from 8 to 10.8 rpm. When it was noted that the axis still was precessing slightly, another shot brought the rate up to 13.9 rpm and corrected the situation.

The reason for the poor quality wide-angle pictures remains obscure. However, the trouble is in the lens, not the TV transmitter. A + mark on the center of the Vidicon target is transmitted clearly even though the pictures are fuzzy.

Some improvement in the quality of pictures between Nov. 23 and Nov. 25 gave rise to speculation the problem might eventually clear up. However, it became apparent that the improvement was merely in the reproduction of the existing poor image.

- **Tracking sequence**—At the Army's Belmar, N.J., ground station, satellite signals are received by a 60-ft. dish antenna, which can be operated either manually, by an automatic lock-on to the satellite's 108 mc beacon or by a slave operation following a program calculated by a computer from the satellite's ephemeris.

Normally, operators on a crew headed by George Goubeaud of the Signal Corps and Ciro Martinelli of RCA operate the antenna manually for the first two minutes after it comes over the horizon ("Alarm 1") and then switch to automatic tracking, called "Alarm 2." The slave program, which is somewhat less accurate since it is based on a 15-point orbit connected by straight lines, is used as backup in case the automatic track fails.

For the first four to six minutes after Alarm 2, depending on the height of the pass, the satellite is commanded to send direct pictures from its TV cameras. Then readout of the 32 pictures stored on tape begins, taking 108 seconds. Infrared data is read out simultaneously, taking 3 minutes, 14 seconds.

Next, the TV cameras are programed for the next orbit. The cameras are instructed to begin operating at a given time after a time signal, called "Alarm 3," a signal which is the last given before the *Tiros* goes below the horizon.

John Maskosky of the Signal Corps is in charge of the readout station, which also develops 35-mm films and transmits them to NASA's Goddard Space Flight Center for Facsimile.

- **Interpretation**—Copies of the films meanwhile are rushed a half-mile away to Building 4, where Edward (Jeff) Albert of the Weather Bureau heads a staff of 14 including experts from the Air Force, the Navy and Allied Research of Cambridge, Mass.

Allied Research invented the procedure by which the *Tiros* pictures are "rectified" so that a picture taken at an angle to the earth can be converted to a sketch of clouds as they would appear when observed from directly overhead.

Sub-points and the satellite altitude are obtained from the ephemeris. Attitude angles are obtained from graphs worked out by Allied. This can also be obtained by visual inspection of the height of the horizon on the picture.

The picture is displayed on an enlarger against a chart showing latitude and longitude curves. Such charts have been prepared in advance for attitude angles varying at 2½° intervals from 0° to 90°.

Next, cloud features are transferred manually from the curved, foreshortened image taken by the satellite to a Mercator grid transfer chart.

The key to the entire operation, of course, is identifying the location of the satellite. Some information can be drawn from the ephemeris. But identification of geographic features is essential. The pictures from the wide-angle camera, covering areas 800 by 1000 miles, make such identification easy. ⌘

Ostrander warns . . .

Space May Cost $3 Billion Yearly

ONE OF THE BIGGEST QUESTION'S facing the Kennedy Administration is a hard decision on whether America really means to explore the moon and the planets.

The cost will be much larger than previously estimated. Maj. Gen. Don R. Ostrander, director of launch vehicle programs for the National Aeronautics and Space Administration, contends as NASA—if it continues the job—may need to spend as much as $3 billion a year by the late 1960's.

Ostrander's figures refer only to projects on the NASA 10-year program. He assumes that the Department of Defense will continue vigorous activity in space, and that NASA will continue to benefit from the fallout.

• **Three approaches**—Probably the biggest single item in the 10-year program, Ostrander feels, will be the launch concept after *Saturn*, to provide for manned lunar landings and return.

At present, the space agency is contracting with industry for a series of studies of three alternative means of providing the launch power. All are extremely expensive. The studies will provide answers to such questions as cost, time of development and scientific and technical personnel required. The approaches are the all-chemical *Nova* vehicle, with perhaps 12 million lbs. booster thrust; the chemical-nuclear vehicle, with a somewhat smaller chemical booster thrust; the chemical-nuclear ve- orbital rendezvous and orbital launch, based on multiple *Saturn* launchings.

If he had to start a crash program today for a moon launch vehicle, Ostrander said, he would have to choose the all-chemical *Nova*. The reason is that not enough is known about either nuclear propulsion or rendezvous problems.

Fortunately, however, there is a year or so of leeway available for study, Ostrander maintains, because the reentry and man-in-space problems related to the payload will not be solved sooner.

• **Billions for nuclear rockets?**—To put men on the moon would require a booster capable of accelerating to escape velocity a package weighing 100,000 to 250,000 lbs. NASA studies indicate this would provide for a return capsule weighing 8000 to 15,000 lbs. By the all-chemical route, such a mission would require a booster in the thrust range of 9 to 12 million lbs.

Ostrander declared there is no doubt in his mind that a nuclear rocket can be developed that will reduce considerably the size of the booster—perhaps to the thrust range of 3 million lbs. The booster cost would thus be reduced.

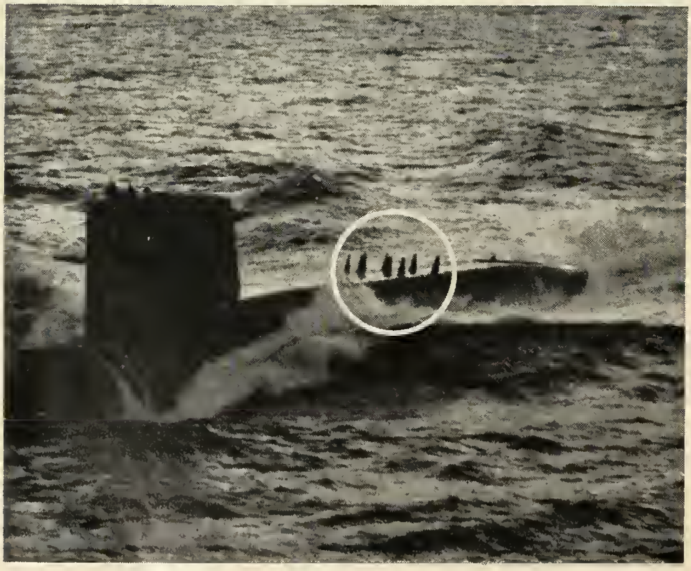
But he maintained that a national decision is required on whether to go ahead with the big nuclear rocket—a multibillion-dollar program.

"There is no doubt in my mind," Ostrander asserted, "that we can develop a workable nuclear rocket if we spend the necessary dollars."

He predicted that within a year NASA will go to industry to begin design studies of a vehicle to build around the *Rover* nuclear rocket. An engine development contract is to be awarded early in 1961.

Before the vehicle goes into development, Ostrander maintains, the nation will have to make a firm decision on whether to go into an expensive nuclear rocket. He added:

"This is part of a still bigger question, the really fundamental one: are we serious about going to the moon and the planets?" ⁂



Fins for Polaris Submarine

FLOW STABILIZER FINS (circle) on deck of George Washington are to correct faulty hydrodynamic characteristics, apparently caused when 130-ft. missile section was inserted in Skipjack-type hull to get sub built in time. AT RIGHT: first photo of GW's missile section interior. Note launch control switches at left. Sub is now on station off Russia.

the elements of Command Control:

Data Acquisition and Application
The measure of any command control system is time. Success depends on how fast the system can close the loop between detected action and counter-action. Command control begins with data acquisition and ends with data application. Here, IBM's experience encompasses subsystems for the acquisition of information from distant and varied sensing devices, and for the presentation of refined data to commanders for military action.

Data Communication
High-speed networks that link command control computers require facilities to assemble and direct masses of data. Time is important. IBM data communication capabilities are evident in systems such as SABRE, a real-time activity control network; and INFORMER, a rugged, mobile field control center. These systems employ communication techniques involving real-time data channels, data conversion and message switching.

Data Processing and Control
Information must be quickly reduced and refined through computer processing to prepare it for command decision. Here again time is paramount. IBM has solved special data processing problems with standard systems such as the 709, installed for space vehicle orbit computations, and advanced systems such as the AN/FSQ 31V, in production for the Strategic Air Command Control System.

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Federal Systems Division, 326 East Montgomery Avenue, Rockville, Maryland IBM®

ARDC Told of Dramatic Advances in Solid Motors

SIGNIFICANT SIZE AND WEIGHT reductions in solid-propellant rocket motors have been achieved by the Air Force.

At last week's ARDC Science and Engineering Symposium in Boston, Edwards AFB scientists described a "headless motor concept" 24% lighter and 37% shorter than a conventional solid ICBM.

Such an order of improvement could have tremendous implications in the U.S. ballistic missile program, opening the way to spectacular performance gains without improvements in propellant energy.

Two new approaches were integrated in the development. The first involved two- and three-grain propellant designs. These are fabricated so that the rocket motor is 100% volumetrically loaded, capable of simultaneous burnout at all points on the case wall, and producing constant mass flow with zero sliver loss. The second provided a multi-stage vehicle design with considerably more propellant-loading volume than in conventional designs.

To prove out the concept, two three-stage missiles were designed—one with conventional solid stages and the other using the headless motor and multi-grain propellant. The results showed that the new missile—the *Muroc*—was significantly smaller and weighed much less than the conventional design.

• **Ceramics for space**—Another Symposium paper described Air Force work in organic coatings for space vehicles. Research to date points to the use of ferrocenes—a class of metallo-organic sandwich compounds which show unusual thermal stability. Preliminary results indicate that such material may be suitable both as a plastic covering and as an improved ultraviolet light absorber.

This is the first material with complete ultraviolet stability ever reported, the speaker said, and it may form a building block for plastics and coatings suitable for very long space exposure such as would be required for use in a space station.

Other significant results from the organic coating research produced the coating for the *Transit* satellites, which established the feasibility of organic temperature coatings for extended space exposure. Also, two organic temperature control coatings have been synthesized for the *Journeyman* space probe.

• **Astronomy aids defense**—A valuable side effect of radio and radar astronomy has been significant contributions to the defense effort, particularly in communications and detection technology, another speaker reported.

Radio maps of the sky provide data for improvement of receiving systems. Solar observations set limits on the sidelobe level of defense radars. Solar measurements have shed considerable light on the communications problems associated with ionospheric and magnetic storms generated by solar disturbances. Antenna calibration and correction techniques have been improved by use of information gained from refraction and absorption measurements of sun and radio star sources.

Optical reflection and back scattering tests conducted at Wright Air Development Division have led to the conclusion that the directivity of passive satellite reflectors can be improved up to 20 times (13db). A paper told how a study was made of three types of reflecting elements: corner reflectors, conical elements, and dipole arrangements. Dipole arrays were found to yield the highest improvement. However, a combination of lenses and reflecting surfaces showed extremely high directivity and versatility in reflection patterns and pointed to their future use in passive communication satellites.

• **Easing re-entry heat**—A new family of guidable re-entry bodies has grown out of work conducted over the last two years at Arnold Engineering Development Center, described in yet another paper. Three variations of a smoothly contoured basic shape with extendable or functionally integral stabilizing surfaces were tested in the Arnold wind tunnel at velocities up to Mach 20. Results showed that the natural fit of the re-entry bodies to the conditions of the heat flow rate equations inherently alleviated re-entry heat problems.

Other papers presented at the Symposium covered such subjects as inertial guidance, bionics, environmental testing, communications, orbit determination, radiation, and high-temperature and high-pressure research. Over 300 DOD scientists, engineers, and delegates attended the sessions. They were welcomed by Lt. Gen. B. A. Schriever, ARDC commander. Dr. Edwin H. Land, president of Polaroid Corp., delivered the keynote address. Sessions were chaired by Dr. A. H. Flax, AF chief scientist.

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Technical Countdown

SUPPORT EQUIPMENT

DAMP Ship Being Modified

Installation of new L-band tracking radar is the primary item in a $2 million modification on Army's American Mariner, AMR Downrange Anti-missile Measurement Program (DAMP) ship. The highly instrumented ship—part of ARPA's Project Defender—is used in making measurements of the physical characteristics of reentry bodies. Modifications are being made by RCA at Capetown, S. Africa.

Army to Centralize Missile Parts Procurement

Procurement of Army missile parts will be centralized under a new Missile and Rocket Inventory Control Center to be set up at Redstone Arsenal. Shipping documents and inventory control will be handled by a digital computer to speed up spare parts order processing.

Recon Satellites for Space Surveillance

Reconnaissance satellites such as *Saint* may provide an improvement in the orbit determination of other satellites, according to an ARDC astronautics expert. Advantages cited include no ionospheric refraction problems, freer choice of radar frequencies, and continuous knowledge of launches and space vehicle maneuvers anywhere on or about the earth.

ELECTRONICS

Cascaded Energy Converters Double Output

A thermionic and a thermoelectric energy converter in cascade have been operated by General Electric researchers to produce double the output of a single unit but without the need for additional heat input. The thermoelectric generator used rejected heat from the thermionic converter. Efficiencies up to 16% or better now are believed possible by the company (existing percentages are from 2.5 to 6%).

Solar Flare/Weather Tie-in Studied

Russian studies of solar phenomena during the last 15 years indicate a decisive relationship between cyclical and maximum activity and global weather, says N. V. Kolobkov in *Priroda*. Observations have proved that in years of high activity there is extraordinary intensification of the circulation of air masses. The result is contrasting and stormy weather and a higher probability of global meteorological catastrophes. Researchers are developing fundamental laws which may be the basis of a method for better long-range weather forecasts.

Semiconductor Sales Level Off

Sales of semiconductor devices for second quarter 1960 failed to increase for the first time in their spiralling history. Decline in transistor shipments was counterbalanced by increase in diodes and rectifiers to make total output about equal to previous quarter. Shipments of other electronic components remained at first quarter levels.

S-45 Satellite to Probe Ionosphere

Valuable data on the effects of the ionosphere on space-to-earth radio propagation is expected from NASA's ionosphere research beacon satellite (S-45), scheduled for launch early in 1961 by a *Juno II*. The satellite will simultaneously transmit on six frequencies: 20, 40, 41, 108, 360, and 960 mc.

PROPULSION

Lunar Leap-frog Proposed

An Aerojet-General scientist says that the only practical way to get to the moon is with a triple-play shuttle system. First leg would be to an earth-orbiting station then, via ion-power, to a moon-orbiter. From here, a rocket-powered landing craft would go on to the moon. All vehicles involved would be reusable. Estimated time for the shuttle would be 3 days, 12 hours, and 20 minutes.

Solid-Motor Size Reduction Seen

Multi-propellant, 100% volumetrically loaded grain designs may produce some significant reductions in the size of solid-propellant motors. Air Force work on the "headless motor concept" has shown that such missiles can be 24% lighter and 37% shorter than a conventional solid ICBM. The technique produces a motor capable of simultaneous burnout at all points on the case wall, producing constant mass flow with no sliver loss.

Heat Shields Protect Saturn Fuel Tanks

The *Saturn* booster, redesigned for its second series of static tests, has two layers in the tail section designed to protect the LOX and fuel tanks against the radiant and conductive heat from the eight engines. A heat shield at the level of the engine throats, and a flame shield between the inboard engines, provide primary protection. Above them, a fire wall protects propellant tanks in event of fire in the engine compartment.

Nuclear Propulsion Offers Big Weight Saving

The all-chemical *Nova* launch vehicle, with 5 or 6 stages and total takeoff thrust between 10 and 15 million lbs., would return a man to earth from the moon in a capsule weighing 10,000 to 15,000 lbs., says Harold B. Finger, NASA-AEC chief of nuclear propulsion. By comparison, a chemical-nuclear vehicle would have only four stages and takeoff thrust would be 3 to 4½ million lbs. The all-chemical vehicle would stand 300 to 350 ft. tall, while the chemical-nuclear vehicle would be between 200 and 300 ft.

ADVANCED MATERIALS

Foam Furniture for Space

Shelter and furnishings may be fabricated of polyurethane foam on the spot by visitors to the moon or planets. A compact, lightweight kit would contain all the materials required for the Space-Age do-it-yourself project. Small quantities of the plastic foam have been produced at Wright Air Development Division and tested in space-simulating low-pressure environments.

760 Million Pounds of Mo Found

The existence of a large molybdenum deposit near Questa, N.M., has been confirmed by Molybdenum Corp. of America, owners of the property. Sample assays indicate that 260 million tons of ore containing about 5 lbs. molybdenum disulphide per ton are contained in the deposit. Moly from mine concentrates currently goes for around $1.25 per lb. and there is an estimated 760 million lbs. of the concentrate in the new field.

Tracker's Range Reaches to the Stars

Military shows interest in Optron system based on an electron tube which provides very accurate tracking data when joined with an auxiliary telescope

by Charles D. LaFond

A VERSATILE AND UNUSUAL electro-optical tracker has been developed which can follow an object with great accuracy over almost any range from 3 feet to stellar distances.

The first prototype has been demonstrated recently by its developer, Optron Corporation of Santa Barbara, Calif. Although it is strictly an in-house-sponsored product so far, several of the military services have expressed considerable interest in the system.

Heart of the equipment is the Model 650 electron tube. Range variations are determined by the accompanying lenses, terrestrial or Cassegrainian telescopes employed with the system.

Range of the tracker, depending on the particular equipment configuration can be 3 ft., 15 ft., 100 ft., or from several miles to stellar distances. Response is from dc to 5 kc with a resolution of 1 part in 1000 (under ambient illumination of 40 foot-candles or resolution of 1 part in 3000 at 100 foot-candles). With these ranges it can be used to measure vibration on a shake table or track a missile in flight.

• **Operation**—Essentially, the Model 650 Tube reacts to the displacement or motion of an object. Through an optical arrangement, the image of a black and white target is formed on the photocathode. The electron image is then presented at the dissecting aperture. (Refer to diagram.)

The "light" portion of the image emits more electrons while the "dark" portion emits fewer electrons through the dissecting aperture to the multiplier.

If the target moves laterally to the right, the multiplier is exposed to more electrons; if target moves to the left, it "sees" fewer electrons.

Multiplier output is fed to horizontal deflection plates. This feedback helps counteract motion as the target moves in space and it tends to keep the electron image at the dissecting aperture. The controlling feedback then is a measure of the displacement of the target.

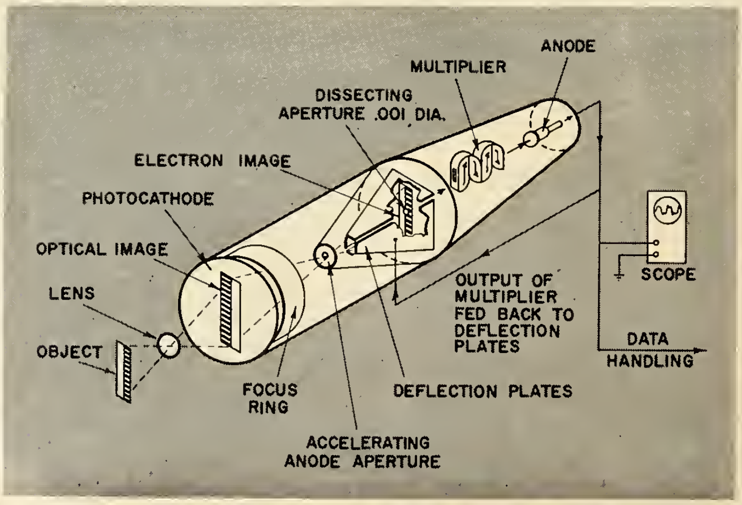
By this means a voltage is developed at the output terminals of the tube that is a direct measure of motion by the object.

Time constant of the tube is 1 microsecond, defection sensitivity is 800 volts/inch, and output voltage is 10 volts full scale at 150 ohms.

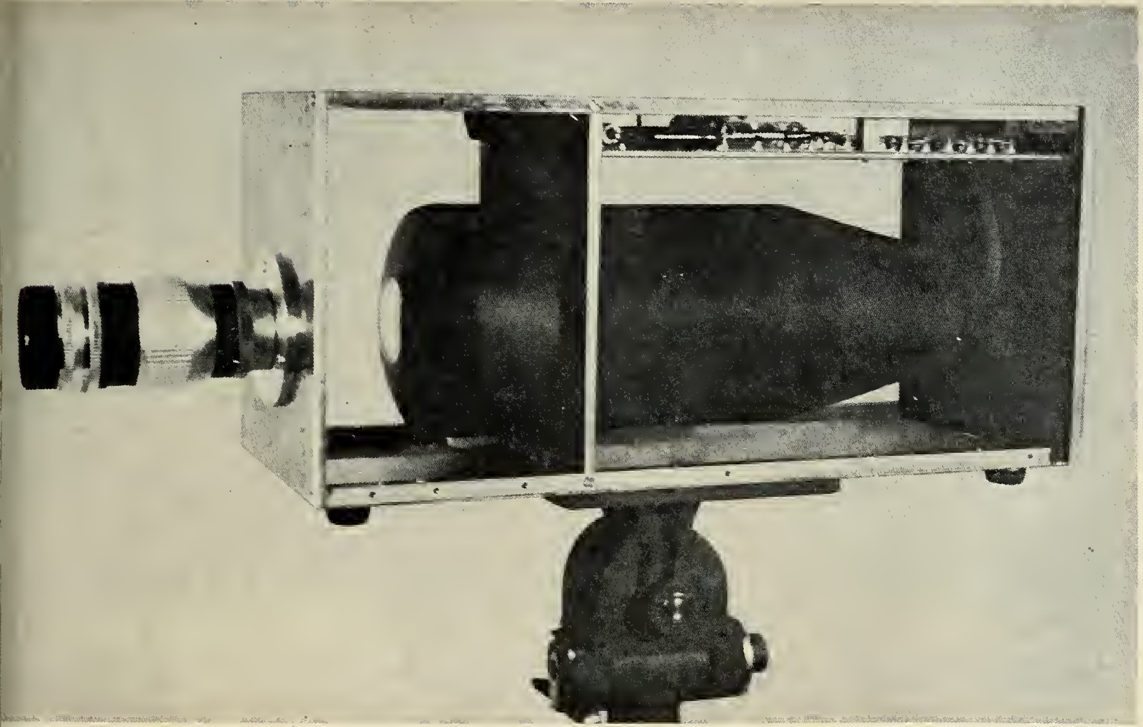
• **Applications**—The system could be coupled with a telescope to provide azimuth and elevation data while tracking a missile. Coupled with such an auxiliary telescope, Optron believes it could be mounted on an Askania or Contraves tracking theodolite to provide highly accurate tracking error measurements in real time during missile flights.

With a 40-inch focal-length telescope Optron feels tracking accuracies of ± 10 seconds are attainable. Also, it feels that a resolution of 0.05 milliradian in a field of view of 10 milliradians is possible.

In this application the visual range of the spectrum toward blue at 4400 Angstroms would be used. A 2 to 130-mile range could be attained and digital



FUNCTIONAL diagram of Optron Corp.'s Model 650 tube in "locked-on" condition and tracking an object in space.



UTAWAY MODEL shows lens and Model 650 tube. Internal ultiplier section is at right in tapered end of tube, and 1-inch-diameter active area of the photocathode can be seen at the left end. Time constant of the tube is 1 microsecond.

ata output would be coincident in me to ± 1 millisecond to the readut of the test tracking mounts.

Other applications suggested by its evelopers are for:

–Remote measurement of dangerus solid rocket propellants (for tensile sts, etc.)

–Nozzle-deflection measurements of rocket engine on static test stand.

–Remote measurement of any moon, vibration or displacement.

• **Typical targets**—As noted earlier, le brighter the target presented, the etter the resolution of the electron nage on the photocathode.

For laboratory or standard test leasurements, the target may be illminated with a light beam from a C source to further enhance resoluon.

Typical targets for the Optron sysm might be a black-and-white image n stiff card stock, any bright reflective lachined edge or a dark non-reflective dge set off by a bright background, ny optical discontinuity, or a selflminous white-hot specimen.

For precision measurements, the Iodel 650 Tracker should be mounted n a seismic stand, a company engineer id. This provides isolation from the oor and permits three-axis swivelling gether with XYZ micrometer positiong leadscrews. ⁂

Hoffman Shows High-Speed Mesa Diode

Santa Barbara, Calif.—A high-speed mesa diode of gallium arsenide has been developed by Hoffman Science Center, a new division of Hoffman Electronics Corp. The company says its response time is less than one-billionths of a second—more than an order of magnitude better than any similar device now commercially available.

Other new developments reported by the facility include a silicone coating for solar cells and an improved fuel cell.

President H. Leslie Hoffman announced these developments during the recent dedication ceremonies at the center.

He said special characteristics of gallium arsenide compounds make them more versatile for electronic equipment requiring high-speed semiconductor devices than the silicon compound now being used. Gallium arsenide compounds combine the capacity for high-temperature operation and high speed response to changing potentials, as well as permitting fabrication of devices with greater stability and reliability than silicon equivalents.

One particularly interesting device being investigated by Hoffman scientists is the parametric amplifier. Use of gallium arsenide makes possible a high or low frequency amplifier which apparently will have greater versatility than transistor devices. When fully perfected, the device is expected to be valuable for increasing the range of communications and radar equipment without requiring an increase in the transmitted power.

• **Aspirin-size cells**—A laboratory model of the improved fuel cell was demonstrated at the dedication of the center. Developed by Dr. Joseph S. Smatko, senior scientist at the research facility, the unit is a self-contained, sealed device about the size of a one-pound coffee can. When used as secondary power sources, cells of its type can be made as small as an aspirin tablet, according to Dr. Smatko. The cell can produce open circuit voltages of 2.8 volts per cell and is expected to have an estimated lifetime in excess of 10,000 charge-discharge cycles.

A new silicone coating for solar cells developed by Hoffman Science Center may increase protection to the cells while maintaining efficiency. The inexpensive method of coating a solar cell by paint-brush or spray technique may also significantly reduce the total weight of the cell, according to Hoffman scientists ⁂

Industry Reliance on Quality Control Checks Continues to Increase

by William Beller

BELOW: *A graphical summary shows personnel and related data comparison resulting from the seventh AIA survey of the industry's quality control problems. This year's report, covering 1959-60, is compiled from a greater number of returns than any of the preceding surveys, and hence is probably most accurate.*

THE TAR-BABY QUESTION o "How much quality control?" got some statistical answers last week.

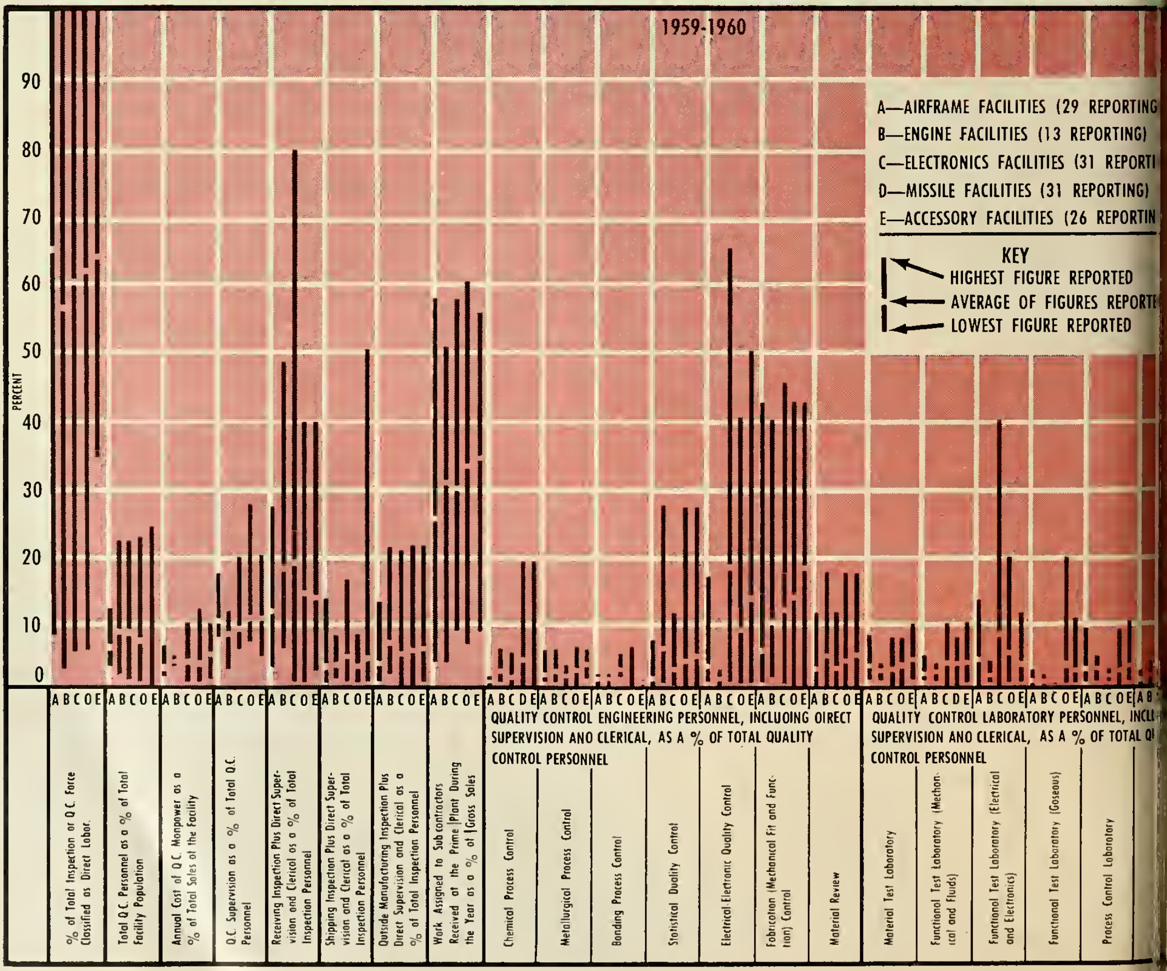
The respondents and their representatives were gathered in Dallas fo a joint industry-government session o the Aerospace Industries Association' 10th annual quality-control committe meeting.

Up for presentation was the committee's 1959-60 "Quality Control Systems Study," based on data furnishe by 98 aerospace companies.

To give all data proper weight, the AIA committee additionally terme "companies" those organizations tha in actuality are divisions or facilities o parent companies. Thus, 130 organizations were surveyed—29 airfram facilities, 13 engine, 31 electronic, 31 missile and 26 accessory manufacturing.

Some of the chief findings:

–Quality Control influences the selection of vendors by maintaining



eview of their quality performance, or 96.1% of the companies; by keeping track of the vendors' capabilities, or 94.6%; and by reviewing or aproving purchase orders, for 70.7%.

–A reliability group or its equivalent xists in 85.4% of the companies. Last ear this figure was 81.4% and the ear before, 61.5%.

–Quality Control gives management end reports of manufacturing perormance in 70.7% of the companies.

–Most of the companies surveyed re doing business with the Air Force, 4.6%; second most popular agency, avy's Bureau of Weapons, 49.2%; ederal Aviation Agency, 31.5%; rmy Ordnance Corps, 23.7%; and he Army Signal Corps, 12.3%.

• A quantitative study—This is the eventh AIA survey of industry's uality control problems. The project as started in 1954 when it was proosed by Paul E. Allen, manager of uality control and customer service at eech Aircraft Corp.

Still directing the work, Allen states that its purpose "is to provide Quality Control managers with a periodic survey of quality control systems and techniques, to be used for comparative reference in evaluating various phases of their control systems."

To avoid having the survey's data used for determining quality control procedures in particular companies, AIA holds all replies to its questionnaires anonymous. This procedure is also said to assure honest answers.

The current report is almost entirely statistical, with scant attention paid to interpretation of the figures. The committee explains that the results are meant to show individual companies only how they compare with their competitors; the report is not meant to say which procedures are best.

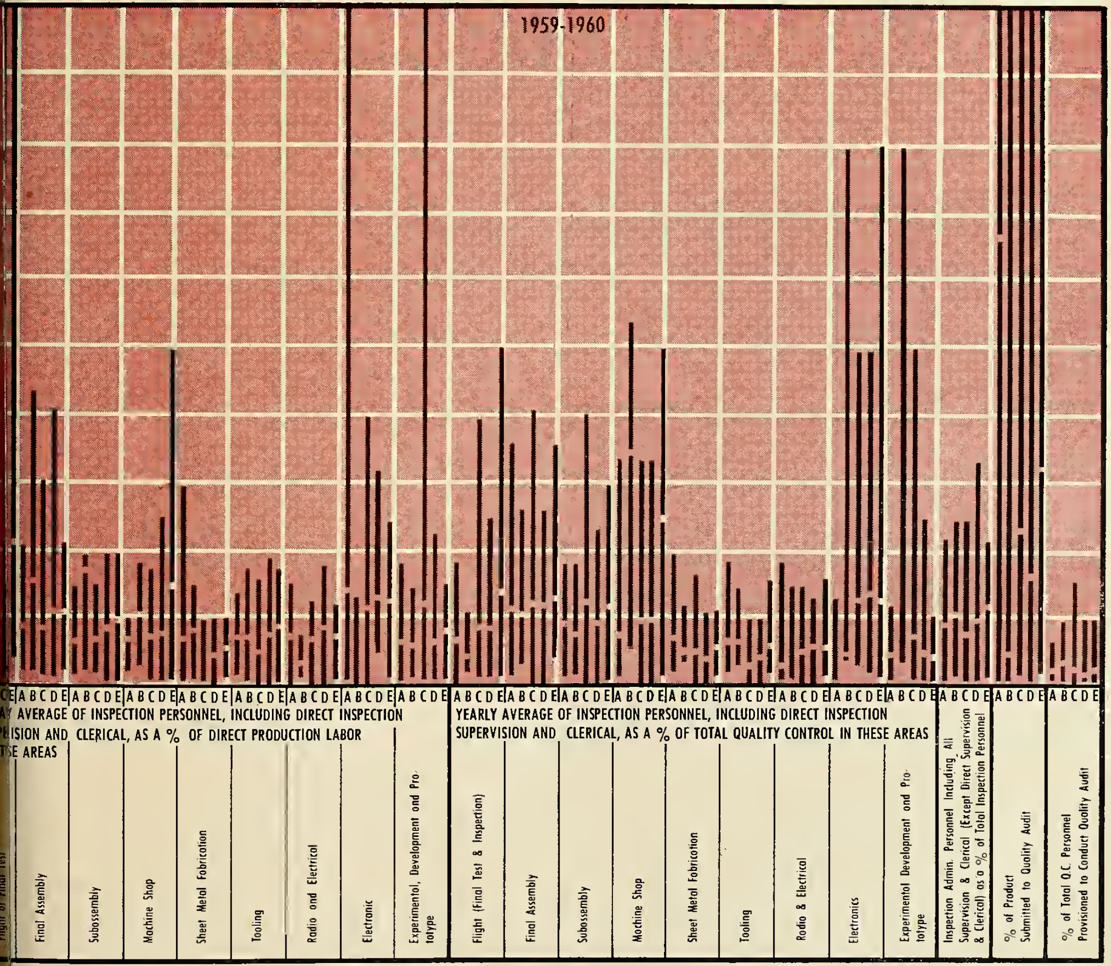
Allen emphasized this point by stating that the report "cannot be used as a departmental measuring stick without analyzing the specific administrative, manufacturing, engineering and management participation within the companies being compared."

He added that if detailed evaluation or comparison is desired, then "it will be necessary, through individual solicitation, to locate the companies who are operating with the techniques or manpower distribution concerned, and individually study the systems on a comparative basis."

Other findings pointed up by the survey:

–Quality Control budgets are based on the percentage of direct labor serviced in 62.3% of the companies, a fixed rate in 13.1% and other methods in 36.1%.

–Sampling inspection of vendor items is performed by 96.1% of the companies, and partial use indicated by 6.2%. None of the companies reported that they did not inspect samples of vendor items. MIL-STD-105 is used by 78.4% of the companies and a



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Solid State Relays illustrated:
MODEL SSR-12-.100 (left)
Model SSR-12-1.00 (right)

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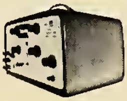

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locally developed sampling program by 50.8%.

–The lot is returned to the vendor by 81.5% of the companies if it is not acceptable under the sampling plan used.

–A preferred source list based on vendor quality history is maintained by 88.4% of the companies. Three additional companies indicated they are in the process of making up such a list.

–The manual system of recording inspection data is again the predominate method with 93.8% of the companies; 62.3% also use IBM type and 8.4% key sort.

–Quality control inspects all tools in 70% of the reporting companies. Acceptance of tools based on the acceptability of parts produced was used by Quality Control in 75.4% of the returns.

–Quality Control maintains standards and calibrates working gages in 80% of the companies. In some instances, this is limited to mechanical or dimensional standards only; the electrical and hydraulic standards are an engineering responsibility. ⌘

Simple Detector Seen Ideal for Satellite Use

A VASTLY SIMPLIFIED solid-state particle detector, now in pilot production, answers the need for smaller, more reliable instrumentation in satellites.

Developed by Semi-Elements, Inc., Saxonburg, Pa., the new semiconductor product can be used to detect X-rays, gamma rays, and other types of radiation.

The detector, according to Semi-Elements, changes resistance by an amount which varies as the radiation level.

Its sensitivity reportedly can be compared directly with that of crystal photomultiplier X-ray detector combinations now in use. Response is somewhat slower, but the company says it anticipates improvements during the next few months.

Another advantage over contemporary detectors is the absence of fatigue effects over prolonged periods of radiation.

The company feels the tiny element has application not only for missile/space use but for such jobs as X-ray inspection on final assembly lines. The detector would pick up variations in intensity during quality control inspections.

The company's laboratory is working to develop more efficient solid-state particle detectors for gamma rays using another single crystal element.

"Scratch the contact – it's a whale."

The false alarms which have continuously plagued antisubmarine warfare operations will be eliminated by a new sonobuoy under development by Chance Vought Electronics Division under the sponsorship of the Navy's Bureau of Weapons. This unique electronic device is being tested now against Navy surface ships and submarines at Key West, Florida.

Vought sees this sonobuoy as part of a family of new ASW systems which would converge from the sea, air and space to pin down enemy subs. Other links in this three-dimensional defense are also taking form at Chance Vought, where the combined resources of all divisions provide the broad capability required.

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Applying Nature's Secrets to Machines

How Air Force scientists search for engineering principles in the sensory, nervous and memory-storing abilities of living things

by Dr. Harvey E. Savely

Director of Life Sciences
Air Force Office of Scientific Research

WE ARE WITNESSING today a rapid "coming of age" of biology as an analytical science. This is due in part to developments in the physical and chemical sciences which are now being applied to the study of the fundamental patterns in living systems. The Air Force, along with other military services, has recently shown an increasing interest in biology as a source of principles applicable to engineering.

The reason is clearly that our technology is faced with problems of increasing complexity. In living things, problems of organized complexity have been solved with a success that invites our wonder and admiration. It is natural, therefore, that we look to these successful inventions in nature for clues, as well as inspirations, for new classes of man-made machines with greatly increased capabilities.

Three interrelated aspects of the nervous system have been occupying much attention in the Air Force. They are 1) the sensory receptors of animals, 2) the integrative action of their nervous system, 3) the storage and retrieval of information.

• **Subhuman sensitivity**—The sensory receptors are the transducers by which animals stay attuned to significant events in the world around them, as well as in the machinery of their own bodies. We commonly think of them as the basis of our five senses. But the receptors are much more varied than we might infer from our human sensations.

Only a few years ago Dr. Bulloch and his associates at UCLA described the sensitive infrared sensing organ in the rattlesnake. This organ, which is located in the pit between the nostril and the eye, is so sensitive that it responds to a change in temperature of .001°C.

Another form of energy which most animals cannot sense except as a shock is electrical energy. Yet at least three families of fish existing in the tropical areas can detect small changes in the electrical field of their surroundings

These fish emit pulses of low voltage in the order of 1 volt—either in bursts or continuously throughout their lives. The frequency and pulse form is characteristic of each species, and ranges from 50 to 1600 cps.

In one species studied by Prof. Lissman of Cambridge University, it was found that the fish was sensitive to a change in the electrical field in the water of .003 microvolts/mm, and could be trained to distinguish between two non-conductors placed in the tank.

• **Beetle dividend**—The ability to make pattern recognition and detect motion has arisen independently in three of the great groups of animals, the vertebrates, the arthropods and the mollusks.

We are encouraging work in all these forms in the belief that analysis of these separate developments in nature could have important implications for pattern recognition and the science of automata.

Studies on insect vision have already yielded an unexpected payoff. Dr. Hassenstein and Dr. Reichardt at the Max Planck Institute have spent several years studying the response of a beetle to moving light patterns.

When the results were expressed in the language of control systems' theory it appeared that the beetle could derive velocity information from a moving randomly shaded background.

The payoff is that these workers have initiated the design of a ground speed indicator for airplanes which works like the beetle eye and is based directly on the function of just two of the hundreds of facets that make up the compound eye of this insect. Other insects have more highly developed eyes and appear to have pattern recognition and color vision as well.

• **Smell and hearing**—The chemical sensing organs are another class of receptors that reach a high degree of development in many classes of animals. It is highly developed in man and some of the other vertebrates, and perhaps is more sensitive in some of the insects. Detection of a variety of odors and of chemical substances is possible in amounts so dilute that it is estimated that one molecule may be sufficient to fire off a receptor. In some cases the receptor is sensitive to specific chemicals and even to separate chemical isomers. This ability makes it possible for a male moth to "home in" on the odor from a female from great distances.

You are probably all aware of the echo location ability in bats, porpoises and other animals that have a kind of sonar. The acute hearing of the owl enables it to be guided accurately in the dark to high-pitched noises of mice.

Perhaps you have not heard of the moth that has developed a highly effective hearing organ, composed of only two cells, which can detect the ultrasonic cries of bats, and which enables it to take evasive action just before the bat makes a meal on it.

There are undoubtedly undiscovered sensory transducers. Birds perform great feats of orientation and navigation by quite unknown sensory systems. There is growing evidence that some of the night migrators may be using some aspect of night sky—perhaps stars—for navigation. These, like some other classes of problems in biology, are still in the phenomenological and descriptive stage, which must precede the identification of sensory mechanisms and analytical studies of their function. This whole area of biological transducers is one that deserves considerably more attention from both biological and physical scientists.

• **Integrative actions**—After the transduction of the physical energy into a nerve impulse having a characteristic digital code, the central nervous system of the animal must carry out digital to analog conversions of the signal for the purpose of analysis and mixing with other disturbances in the nervous system. Here we come up against organized complexity carried to the unimaginable extremes.

Fortunately we do not have to solve the most difficult of these problems first. We have before us in nature millions of examples of information handling, in all degrees of complexity.

We have every right to expect we will be aided in gaining understanding of the more complex systems by first studying them in simple organisms. To understand this aspect of the nervous system new concepts in physics and mathematics may well be needed. It is here too that the application of computer simulation techniques may play an important role. For we still do not have the methods for tackling problems of organized complexity which is characteristic of living systems.

• **Mystery of memory**—A third aspect of biological systems that should ultimately have profound implications for engineering is the ability of living things to store and retrieve information. This is a characteristic phenomenon of all living things even at the cellular level, where metabolic activity is influenced by preceding events occurring hours, days, or generations before.

In the nucleus of the cell is stored the pattern on which an additional copy of the organisms can be built. We know nothing about the code by which this pattern is stored or expressed. To reflect for a moment on the mass of detailed information which must be needed to guide the development of an animal—such as ourselves—is to be awed by this problem. A beginning is being made on the problem by the study of the structure and characteristics of the large molecules that carry out the transmission of genetic information. Great strides have been made in the last 10 years. They promise to have far-reaching importance for all the sciences and the technologies that rely on them.

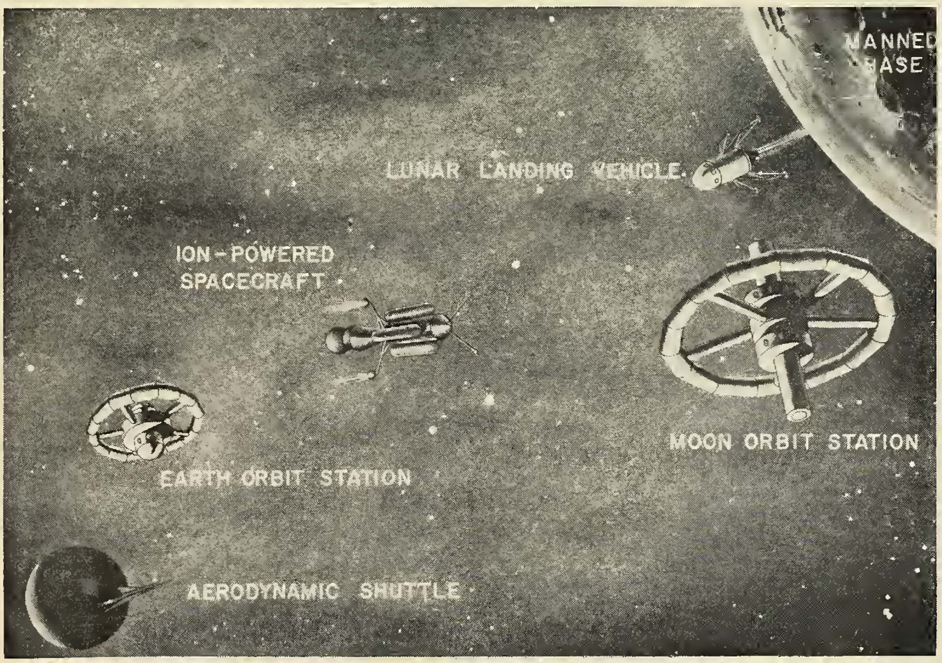
Storage and retrieval of information at the level of the central nervous system underlies both the conscious behavior in man and the short and long span memory in animals. Unfortunately, we can say very little about the biologically fundamental aspects of the molecular systems that are at work in all cells. It stands as another aspect of the great challenge of the biological sciences. Its implications are so great that it must be a part of any military program of basic research.

In discussing living systems as prototypes for engineering application one should take note of a conservative attitude which may be encountered among some biologists. The biologist is greatly impressed by the scope of his ignorance, and rightly so. He realizes that he does not have in hand the fundamental laws that govern the phenomena with which he deals. He may feel that the strategies appropriate to the physical sciences, which have dealt mostly with unorganized complexity, will not be adequate to deal with the organized complexity of living systems.

• **Nature's limitations**—Above all, he fears that the engineering scientist may be misled into thinking that ready-made solutions to his problems may be hidden in the biologists' notebooks. The biologist must point out that nature has been limited to building upon and modifying pre-existing structures to produce new systems; as a result she often takes a roundabout way to solve her problems. Imitation of nature's solutions may not be practical. First what is needed is to understand the underlying principles involved. Then we may be able to apply them in ways that may not exist in nature.

Compare bird flight to airplanes, for example. Imitation here did not get us very far. A basic research program 60 years ago on the structure of feathers would obviously have led us into a blind alley. It was the understanding of the physics of air flow that spurred our development. In the same way we must look for the fundamental principles at work in the nervous system and not be tempted to imitate what may turn out to be the "feathers."

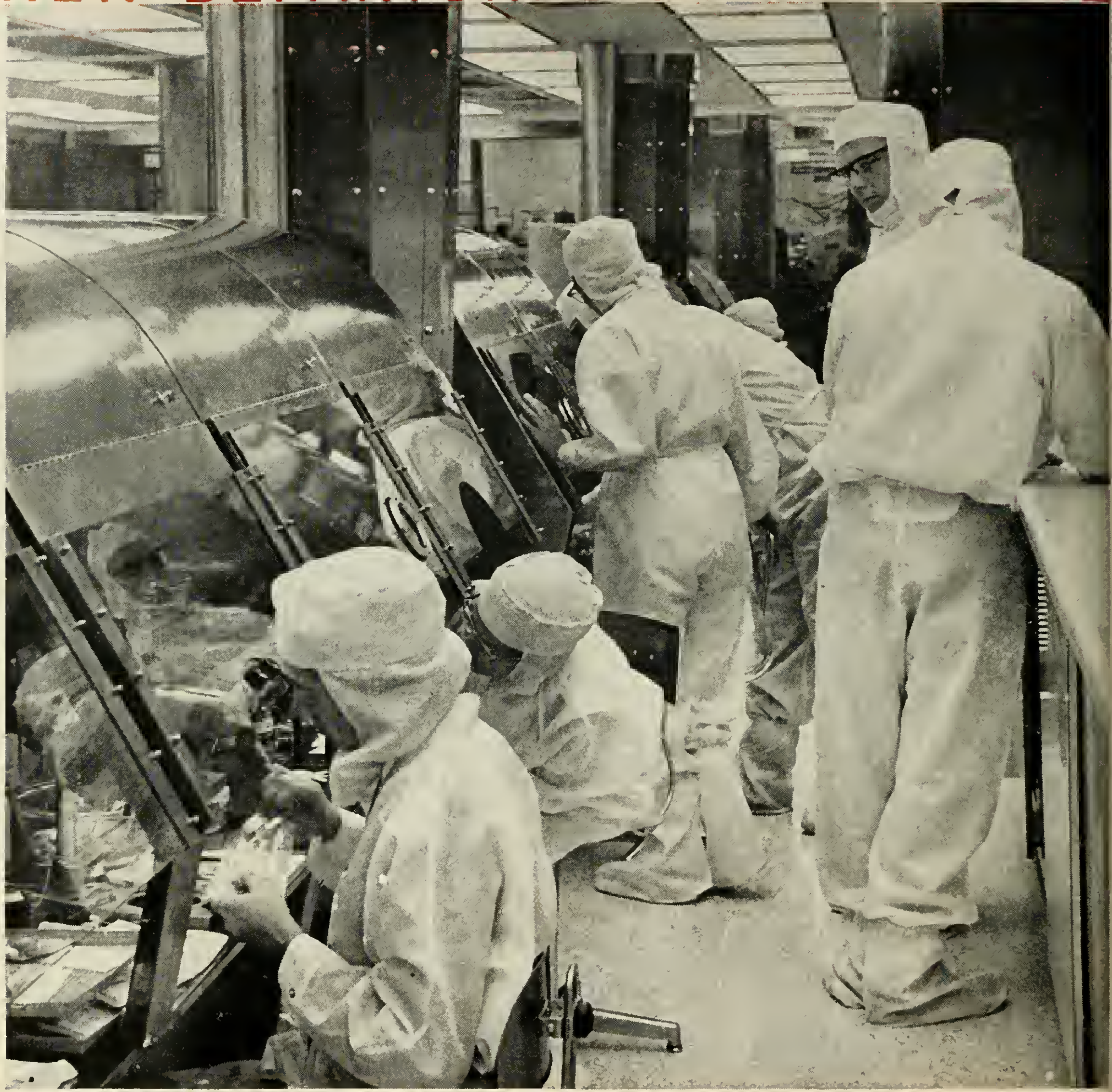
I am optimistic about the applications of biology to engineering. My optimism is based on the solid progress now being made by analytical approaches to biology and in the attraction of mathematicians and physical scientists to its problems. ⁂



Three-Stage Moon Journey

ARTIST'S concept by Aerojet-General shows aerodynamic shuttle leaving earth (lower left) to discharge men at earth orbit station from whence ion-powered craft would take them to moon orbit station. Final landing would be by rocket-powered lunar landing vehicle.

NEW DEPARTURES IN MINIATURE



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Redstone Culprit

Stray Current Foiled Launching on Nov. 21

A FREAK STRAY CURRENT resulting from faulty circuit design in the *Redstone* booster has been identified as the cause of the Nov. 21 *Mercury Redstone* failure. The circuits are being redesigned and another launch will be scheduled soon.

Dr. J. P. Kucttner, *Mercury* project officer at the NASA Marshall Center in Huntsville, Ala., said a few milliseconds delay between the unplugging of two clocks in the battery control circuitry caused a bogus engine cutoff signal, which actuated the launch tower jetison normally programed for 34 miles altitude.

• A 'First' of sorts—

Although a similar premature cutoff would have been possible on any of the previous 60-odd *Redstone* flights, it never had occurred, Kuettner declared at a NASA press conference. He said it is possible that the improved relays added to the circuits for the man-in-space program were more sensitive to such a tiny stray current.

After the Nov. 21 failure, NASA engineers waited 31 hours for the *Redstone's* LOX to boil off before returning to inspect the *Mercury* capsule. But if a similar incident took place with a man in the capsule, a long boom device called a "cherry picker" would have been used to get to the astronaut and remove him.

Normally, in the event of malfunction on the pad, the capsule escape system would lift the capsule free and return it to earth by parachute. However, the escape rockets were on open loop for the MR-1 test and the capsule escape could have been actuated only by ground command.

Robert R. Gilruth, Project *Mercury* director, reported that the Nov. 8 failure of the escape mechanism in a flight from Wallops Island, Va., had been traced to a spurious signal from a limit switch.

• Vibration villain—

He explained that the program of the *Little Joe* flight called for opening of a clamp ring between capsule and booster, which would have actuated a limit switch, which in turn would have signaled the firing of the escape rockets.

However, during launch, high dynamic air pressure apparently caused vibration in a limit switch and set off the escape rockets before the clamp ring opened. As a result, the capsule never separated from the booster.

The circuit is being redesigned to eliminate the *Little Joe* difficulty too, Gilruth reported. ⌘

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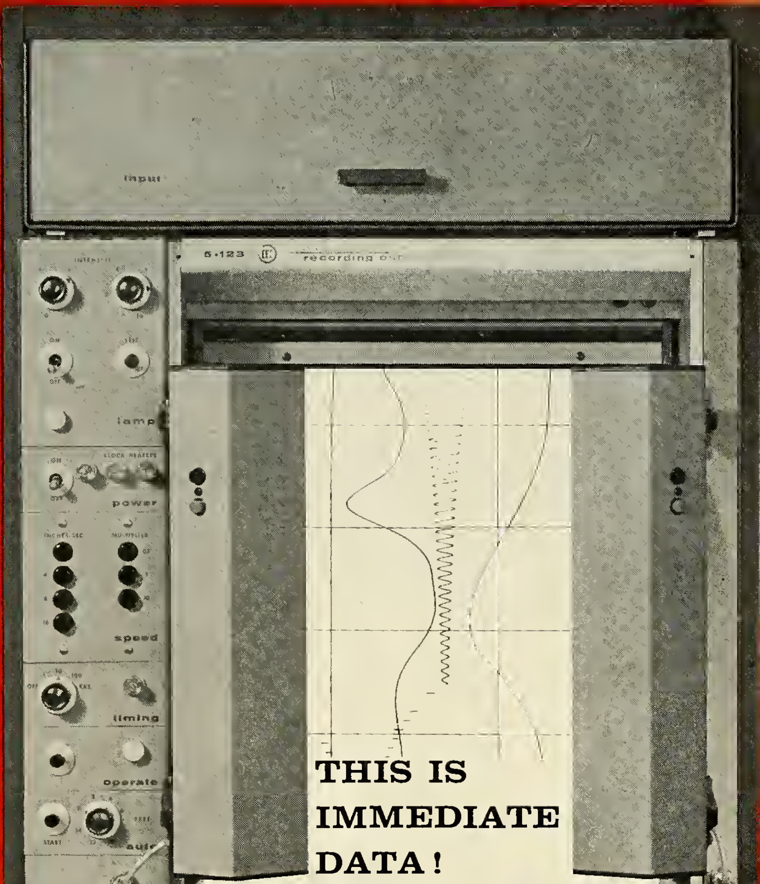

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*Patent Pending.

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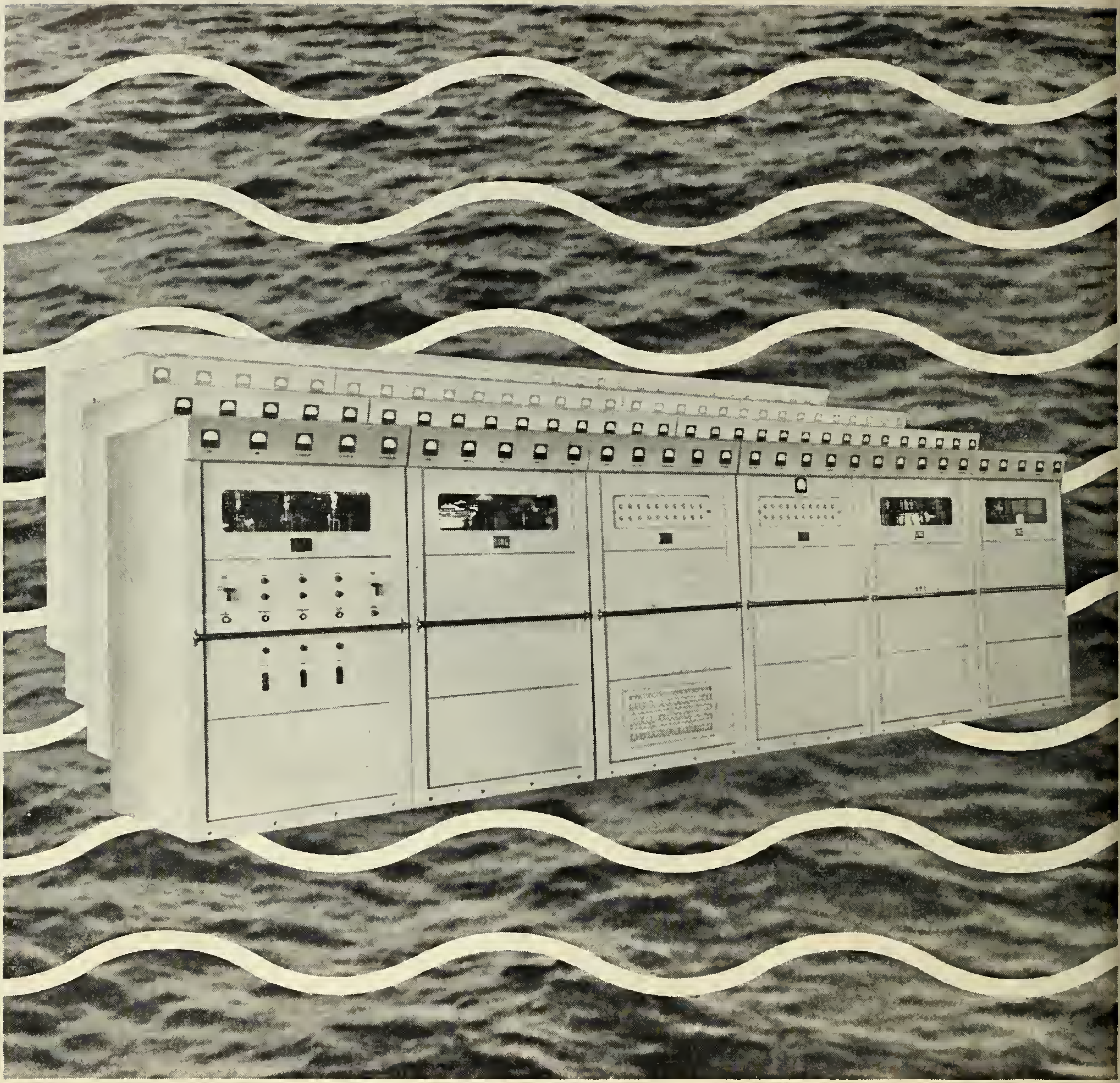

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The powerful amplifier shown at the left has a lot in common with other Ling products. It is a practical example of the sensible way Ling engineers approach their work. Not only is the unit self-contained, but a fool-proof interlock system provides full safeguards for personnel and equipment. If any door is opened the system automatically turns off power, discharges high voltage supplies and energizes convenience outlets and service lights.

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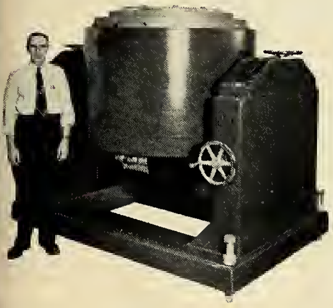

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DOD Tells AIME of Need To Cut Lab-to-Hardware Lag

PHILADELPHIA—Heavy emphasis on research by both the Defense Department and industry in general appears to be creating a problem of increasing proportions.

The conversion of the laboratory development into usable engineering materials and processes is moving too slowly.

The Fall Meeting of the Metallurgical Society of the American Institute of Mining Engineers heard Army and Defense spokesmen point out that our lead time runs almost eight years from lab to hardware, while the Russians have cut their engineering gap to five years.

Meanwhile, the American Society for Metals was told by Edward G. Budd Jr., of the Budd Co., that much of the progress made in research has not yet been put to work because American industry is caught between inflation and corporate taxes. Not enough money is available to take advantage of the laboratory advances. Budd was speaking specifically of depreciation allowances, which practically force industry to operate with obsolete production equipment.

J. R. Townsend, Special Assistant to the Director of Defense Research and Engineering, told the AIME that the DOD is "vitally interested in the possibility of creating ductile ceramic materials."

Recent "breakthroughs" listed by Townsend included: single crystal beryllium, production of amorphous metal by rapid cooling from the liquid state, refractory material forming by exploding wires and the pulse forming of metals.

Other AIME sessions covered pressure vessels, cryogenic propellant tank materials and nuclear metallurgy.

- **Explosive forming competitive**—Cost savings of about $10,000 over other processes have been achieved by use of explosive forming methods to square the ends of rocket-engine thrust-chamber tubes, according to Dr. L. C. Stukenbruck, supervisor of explosive forming activities, Rocketdyne division, North American Aviation.

"We have demonstrated conclusively that the repetitive forming of common metals can be achieved at competitive costs," he told the A.S.M.

The thrust-chamber tubes described are made from nickel and 20CB steel. Over 2000 tubes have been processed to close tolerances by explosive forming with "neglible rejections."

Although the high-energy forming process has been developed with an accent on its application to difficult, high-strength materials, Stukenbruck emphasized its application to less exotic problems. Rocketdyne has used the method to form a quantity of small, stainless steel thrust chambers for a drone rocket engine, and to form pylons of 6061 aluminum (T-4) used to attach *Hound Dog* to B-52G wings.

Much of the saving possible with explosive forming is in die costs. Tooling costs were cut almost $500,000 over comparable costs for the male and female dies, drop hammer approach to fabrication of stiffeners for a large B-70 bulkhead. The part was formed explosively with a single, female die. ⌘

Cornell Finds Way to Stop Convection Heat Transfer

Cornell University scientists have discovered a phenomenon that may go a long way towards solving the cooling problem of re-entering space vehicles.

The find, made in connection with an Avco Corp. re-entry research program, is that heat transfer by natural convection may be halted by spin.

Convection is that form of motion in a fluid or gas caused by density differences and gravity. The motion is created by the application of heat, which usually results in a localized decrease in density.

Cornell researchers have shown that when spin is introduced about a vertical axis, an additional stabilizing force retards heat transfer by convection.

Secondly, when instability does occur under spin conditions, the resulting motion may be oscillatory rather than in a single direction.

Using mercury as the liquid medium, researchers have succeeded in stopping convection heat transfer at a spin rate of 6 rpm when under a heat flux of 1725 Btu/hr/sq. ft.

A variety of containers and liquid metals are under study. Investigations are proceeding under a $72,100 National Science Foundation grant.

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THE MISSILE/SPACE WEEKLY

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Wire Yields Surprising Heat Volume

Cohn Corp.'s 'Pyrofuze' composite looks useful for detonators; low-temperature ignition and controlled reaction

by John F. Judge

A VERSATILE WIRE composite leveloped by Sigmund Cohn Corp., Mt. ernon, N.Y., provides an unusually arge amount of energy when ignited at elatively low temperatures.

The development has resulted in the ormation of a Cohn affiliate, Pyrofuze orp., which is manufacturing and arketing specially processed pyroforic roducts bearing the name Pyrofuze.

Initial experiments with Pyrofuze ire indicate that it may have applica-on in the field of detonating devices, here its behavior is a singular ad-antage. Pyrofuze is composed of pal-dium and aluminum in intimate con-ct. When the system is heated to the elting point of Al, an immediate othermic alloying action takes place d a surprising amount of heat is erated.

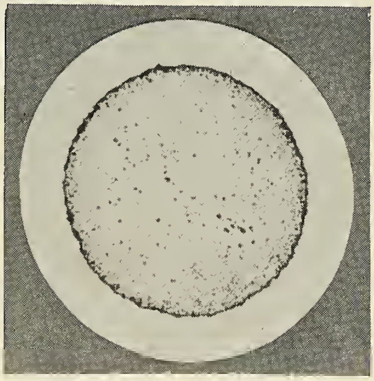
• **Controlled ignition**—The reaction ccurs at a rapid but predictable rate; can be limited or controlled by vary-g the amounts of constituents or anging the ratio of surface area to ass. Normally, ignition is triggered ith a small amount of electrical ergy.

Calorimetric measurements show at 327 calories per gram are liberated -resulting in temperatures in the range 2200° to 2800°C. The reaction takes ace equally well in air, in inert gases in a vacuum. The end product is an loy of the starting materials in the rm of small particles which have been attered by the force of the reaction. some cases, small amounts of alum-um oxide have been found.

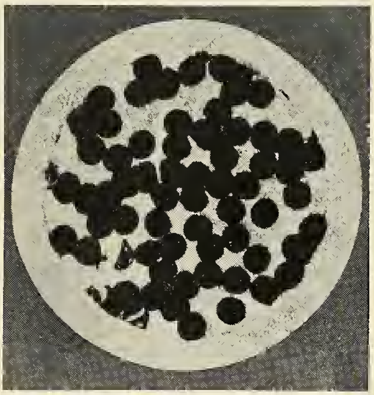
It is believed that the alloying ac-on is the source of the heat, but it is o possible that certain quantities of cluded oxygen are contained in the etals.

Since Pyrofuze is all metal, the re-tion is neither an explosion nor a rning process in the ordinary sense.

In practice, both palladium and uminum are rather soft, weak, and of w electrical resistivity. Improvements tensile strength and electrical properties are gained when 5% magnesium is added to the aluminum and 5% ruthenium to the palladium.



CROSS-SECTION of Pyrofuze wire shows the intimate metal contact attained.



ALTERNATE form of the wire consists of multiple Pd and Al wires in an Al jacket.

The material is usually supplied in the form of a wire having a single concentric core of aluminum and an outer layer of palladium. In the manufacture of single-core Pyrofuze, an aluminum rod is inserted into a tightly fitting palladium shell and the composite drawn into wire. As far as the reaction is concerned, it does not matter which material is used in the core; to facilitate drawing, however, the harder metal is chosen.

In order to prevent the possible formation of a barrier layer of aluminum oxide, the aluminum is electroplated with a thin, non-reactive film of either gold or nickel. As the drawing progresses, this film becomes so thin as to be virtually non-existent.

The firm has drawn Pyrofuze to 0.0009 in. diameter and it is available in this and larger sizes. There is some indication that even finer diameters will be drawn in the future. An alternate form consists of multiple palladium and aluminum wires closely pressed together in an aluminum jacket.

• **Assorted shapes** — Considerable success has been achieved with the pressing of the metals as powders into pellets and other special shapes. These react with greater violence than the wire—probably because of their confined volume with respect to surface area.

If Pyrofuze wire is ignited at one end by any means, the reaction proceeds steadily with a reliable and predictable rate of speed to the other end. The rate of travel will vary with the diameter but may also be adjusted to suit particular requirements. This is accomplished by changing the ratio of the metals or by using multiple strand wire.

If the wire comes in contact with a heat sink, the reaction will extinguish itself. The reason is that the sink reduces the temperature below the critical level. Thus it is possible to stop the reaction at any point through the location of a heat sink.

The material is stable in any form at ambient temperatures. But if it is kept for long periods at elevated temperatures, a slow diffusion may take place between the metals, and the wire may ultimately become inactive. Since both time and temperature is involved, detailed information is not available.

Pyrofuze is not a replacement item. It must be designed into a system. According to the firm, the material's versatility lends itself to this approach. ⌗

Centaur Set for First Engine Tests

by William J. Coughlin

THE FIRST *CENTAUR* VEHICLE is now installed in a test stand at Convair's Sycamore Canyon facility near San Diego.

This is a propulsion test vehicle which will be used to check out the complete propulsion system in a mating of the two Pratt & Whitney liquid hydrogen engines with the Convair airframe.

It is the forerunner of six flight vehicles which Convair will build under its present NASA contract (M/R, Nov. 21, p. 43).

The LR 115 engine has already achieved firings up to 5 and ½ minutes at P&W's West Palm Beach facility, according to Richard C. Mulready, project engineer. In a paper prepared for the upcoming ARS convention, he disclosed that 2500 test hours—some 500 on bearing configurations alone—have accumulated since engine development began in Oct., 1958.

The hydrogen and oxygen propellants produce a specific impulse of 420 seconds—35% higher than LOX-RP. Mulready said the LR 115 rated 15,000 lbs. thrust. The engine operates at a nominal chamber pressure of 300 psia with a nozzle expansion ratio of 40 to one.

First flight of *Atlas/Centaur* is scheduled on the Atlantic Missile Range by mid-1961.

Centaur's first mission will be an attempt at a 24-hour orbit, although initial flights will not be directly connected with the *Advent* communications satellites to follow.

Much of the instrumentation in the first vehicle will be aimed at evaluation of zero-g conditions.

Problems associated with the storing and pumping of liquid hydrogen under zero-g conditions are of prime interest in the initial tests.

The first flight *Centaur* will carry a TV system to monitor by means of telemetry the behavior of the propellant in the tank. Thermocouples will be welded to the wall of the tank and liquid gas sensors will monitor the system.

Extensive cold flow tests of the liquid hydrogen system already have been carried out on the ground in a special test rig set up at Point Loma near San Diego (cover photo).

- **Some specifications** — Newly-disclosed design details of the space vehicle indicate that the total length of *Atlas/Centaur* will be about 110 ft., including booster, *Centaur* and payload. First stage is a basic *Atlas D* modified for space use. This will fly on a programer with no first-stage guidance, although it will be possible to use second-stage guidance with the first-stage autopilot.

The *Atlas* tank structure, tapered for missile use, will be held to a constant 10-ft. diameter for use with *Centaur.*

The high-energy *Centaur* second stage, about 35 ft. in length including nose fairing, will be powered by two LR 115's. Gross weight of the second stage will be in the neighborhood of 32,000 lbs. Like *Atlas*, the *Centaur* upper stage is built of thin-gage stainless steel (301 series) lightly pressurized to maintain shape. Fibreglass and honeycomb also are used in the construction.

Pitch, yaw and roll control will be maintained with the aid of a sun sensor and 10 Bell hydrogen peroxide rocket motors, including four 50-lb.-thrust ullage rockets and six smaller verniers.

A weight saving of hundreds of pounds has been achieved in *Centaur* with an unusual boost pump system for the liquid hydrogen. Use of a boost pump in the line to the engine, together with the engine pump, permits an initial low tank pressure of 5-6 lbs. This has made it possible to design tanks with thinner skin and to reduce the amount of helium required for pressurization.

AERIAL VIEW of Complex 36 at Atlantic Missile Range, being built for launch of Centaur before mid-1961. Note the unusual right-angle flame deflector.

Pumps for the system, built by the Pesco division of Borg-Warner, will be run by a hydrogen peroxide turbine drive built by General Electric.

- **Components cut** — Simplicity of the engines is the key to what is expected to be high reliability for the vehicle. Considerable reduction has been achieved in the number of components. There are, for example, only three valves in each engine. Engine development is well along, with Convair, NASA and P&W reportedly well satisfied with results to date. Some later engine tests will be carried out at Edwards Air Force Base.

The same engine, uprated to 17,500 lbs. thrust, will be used to power the *Centaur* upper stage for *Saturn C-1*, as well as the second stage under development at Douglas Aircraft.

All-inertial guidance system will weigh about 145-lbs., employing a four-gimbal platform with three-axis stabilization and a digital computer. Contractor for the system is Minneapolis-Honeywell, with Librascope as a subcontractor on the computer.

A *Centaur*-type vehicle was first proposed by Convair in December, 1957, shortly after *Sputnik I.* The initial $7-million contract for *Centaur* was let to Convair in December, 1958. #

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Automation Promises Better Testing

- **Douglas Servo Lab expects its system to give more accurate data than manual tests—faster and cheaper**
- **Increasing requirements and costs of accompanying expansion forced firm to turn to test automation**
- **RW-300 computer, heart of the system, replaces human control of adjustment and measurements**

by B. C. Moore
Flight Test & Research Specialist
Testing Division
Douglas Aircraft Co.
Santa Monica, Calif.

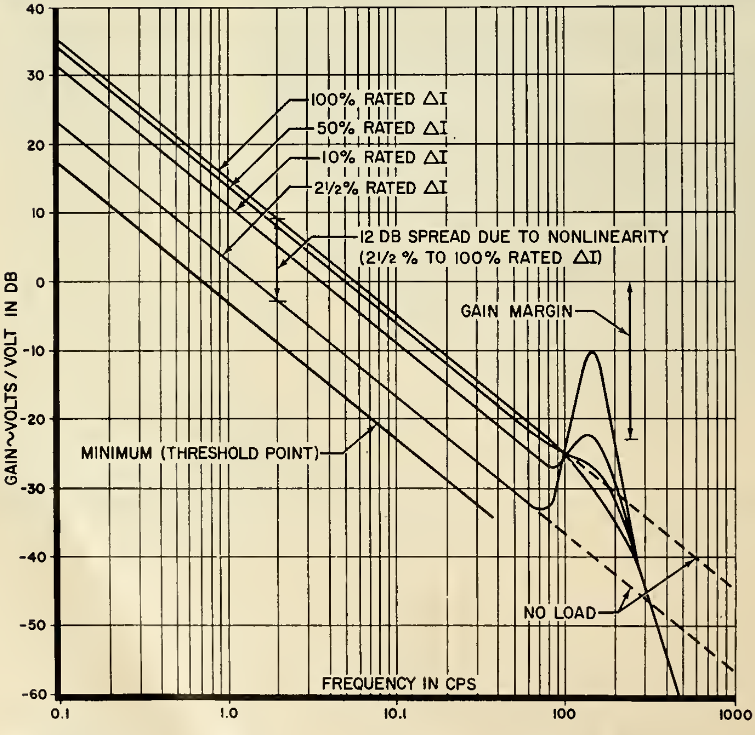

FIGURE 1—Typical test data from the Douglas Servo Laboratory's test system shows the slim margin between high- and low-gain limits, due to valve nonlinearity.

TECHNIQUES THAT MAY revolutionize the art of components testin are now being used by Douglas Ai craft Company.

Through automation, the Company Servo Laboratory believes it can pr vide more accurate test data than wa ever obtained manually—and do faster, cheaper and with less part break down. The same techniques of auto mation can be applied to almost an kind of test of components or system

Douglas began extensive respons testing of hydraulic servos during th development of *Nike-Ajax*, almost 1 years ago. In those days, the servo were a continual bottleneck. Rejectio rates were high, production rates lov

Good valves were flown directly t White Sands Missile Range for firin Rejected valves were rebuilt again an again. Costs of testing ran many tim the cost of production.

Why must servos be tested so e tensively? Servo gain is always limite top and bottom. High gain caus oscillation of the inner loop, often at mechanical reasonance of the serv load (such as missile fin and driv shaft). Typically, this is a high-energ oscillation-bursting forth with muc noise and vibration, breaking parts i a very short time.

Low gain causes hunting or sligh changes in direction of the complet missile in the valve "dead spot." Th margin between high and low gai limits is slim, eaten away by valv nonlinearity. (See Fig. 1).

• **Servo gain tests**—Servo gain tested by driving with a sine wave an measuring the response. Frequencie must be varied from the low missil hunting frequency up through the inne loop resonance.

At each frequency this nonlinea system must be tested from the threshold of motion up to full throw (fro stop to stop). As a cross-check on th sinusoidal response data, the servo driven unstable by increasing the gai

Equipment for conducting the response tests has evolved graduall with considerable experimentatio Driving and feedback sine waves a displayed on an oscilloscope togeth with reference voltage lines. Amplitud

OVER AND UNDER THE TOP OF THE WORLD

In early 1960, American craft pierced the North Pole in two elements. Fathoms below solid ice, the USS Sargo probed unerringly to "90 North"; miles above, a GAM-77 missile on a B-52 pinpointed the featureless goal. Both used Inertial Navigation systems by Autonetics—where today's results pave the way for tomorrow's breakthroughs.

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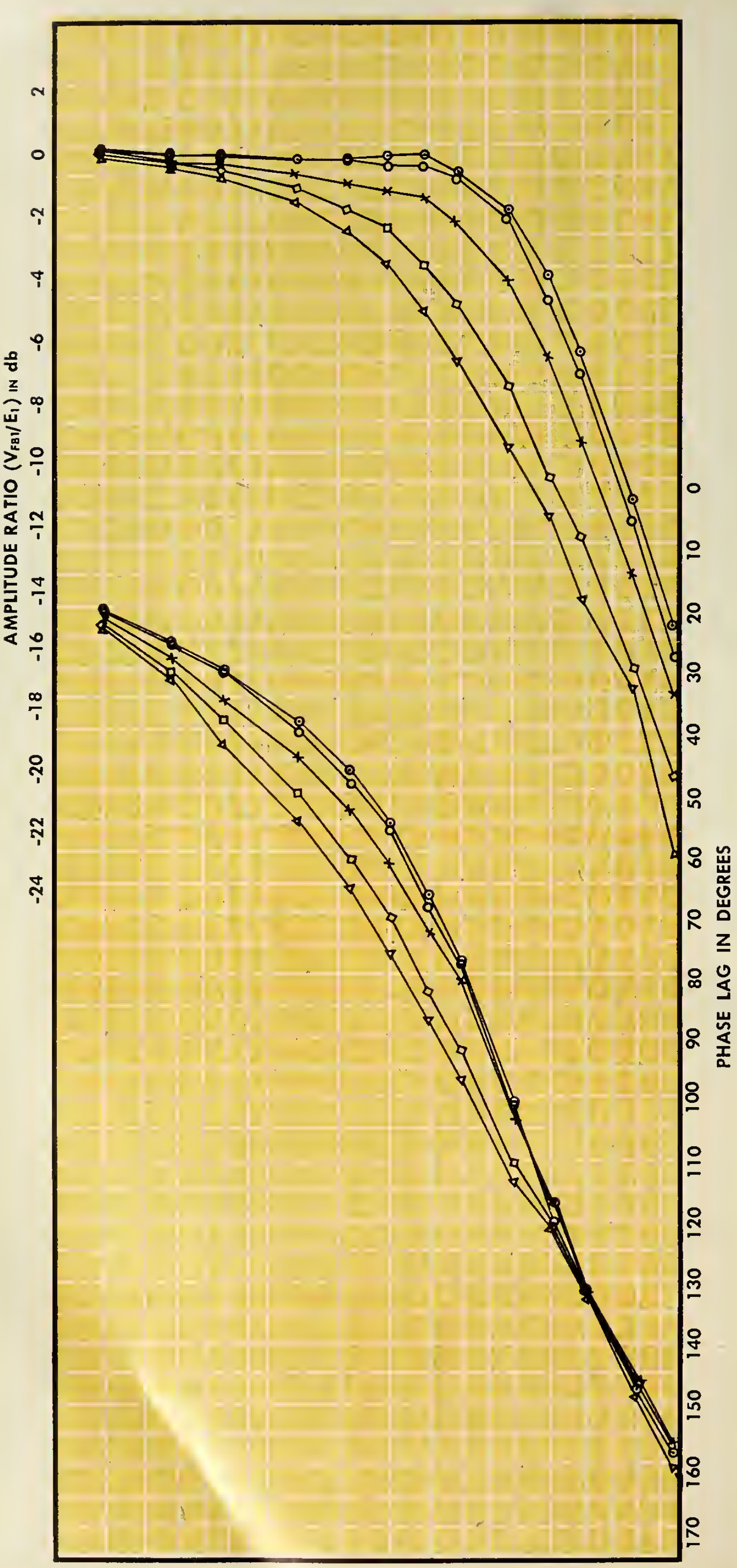


are measured by adjusting reference voltages to match the sinewave peaks, while relative phase is measured with Lissajous patterns.

- **Skill-level high**—A built-in problem is the fact that highly skilled operators are needed to make these measurements—servos driven at high frequency and full power simply don't last long. An inexperienced operator will break down the servo before the first test is finished. Since he is unsure, his response is not quick enough. O-rings often fail, spraying hydraulic fluid at 3000 psi; the bearings are beaten out, changing the response data. Occasionally a shaft breaks.

- **Requirements have tightened**—Over the years, the test requirements have steadily increased. Servo performance has been measured at arctic temperatures (where the oil gets thick and the dead spot increases), at high temperatures where O-rings fail, with g-loads and vibration effects causing spurious valve response, with the use of contaminated fluid to jam the valves, and with simple wear.

Higher flow rates, higher temperatures, more linearity, and more reliability were continually being developed.

- **Facility costs grow**—Facilities developed exponentially. A dust-free area was built—and then expanded. Test cells for high and low temperatures were built with fire-proof doors and closed-circuit TV for safe, remote operation. Hydraulic pumps for hot and cold fluids and electronic servo drives were continually added. Total investment passed $1 million, and more than 30 engineers and technicians were needed full time.

This expansion road could not be followed indefinitely. In the fall of 1957

Figure 2
Results of Typical Test

Outcome of an automatic servo test at Douglas Aircraft Co. At right, columns of results from the computer. At left, curves reflecting a portion of the data in the columns. The unit tested was a hydraulic servo. The computer and associated equipment were provided by the Thompson-Ramo-Wooldridge Products Co.

a study was initiated to develop future facility requirements. The possibility of making better use of existing facilities through test automation was very attractive. For example, fast testing might permit simple blowdown hydraulics for extreme temperatures, rather than requiring expensive pumps with heaters and coolers for steady flows.

- **Automation the answer**—The more automation was studied the better it looked. In May, 1958, bids were invited to a performance specification.

Industry responded generously with some very interesting analog systems, paper tape controlled systems, and general purpose digital computer systems. The comparison of these systems included cost vs. speed (or cost per test station); reliability (the penalty for down time is enormous); accuracy of data and flexibility.

A contract was awarded in August, 1959, to Thompson-Ramo-Wooldridge Products to supply an RW-300 digital computer and associated equipment. Delivery followed in May, 1960. This was integrated with Douglas Aircraft Co. (DACo) built equipment and placed in operation.

Results of an automatic test of a hydraulic servo are shown in Figure 2.

- **Equipment setup**—A block diagram of the automatic servo tester is shown in Fig. 3, in which the heart of the system is the RW-300 computer. A drum machine, with 8000 word storage, it is highly reliable.

Operating records indicate 1000 hour mean time between failures; a guarantee of 500 hours was given. Program input is through a Flexowriter on paper tape. Switches (54 provided) can be sampled by the program for additional data or instruction and four analog voltages can be sampled on program command.

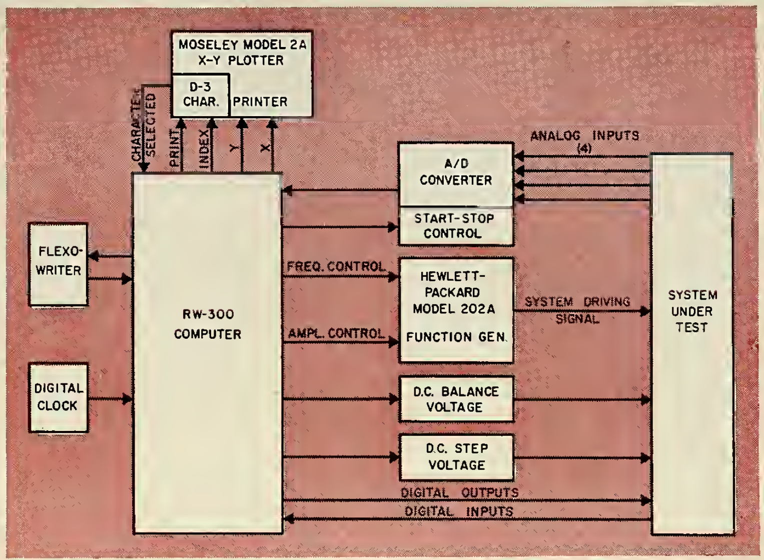


FIGURE 3—Block diagram of the Douglas automatic servo test system.

A short burst of 1024 words in about ¼ second can be written on the drum for later analysis—or a continuous sampling mode can be commanded.

The computer controls peripheral equipment through relays. It operates the Flexowriter and X-Y plotter, adjusts the frequency and amplitude of the driving signal, adjusts dc voltages used for balance and step inputs to the servo, selects the servo amplifier networks and gain, picks the signals to be measured and adjusts signal-sealing amplifiers.

In short, it performs all the previous manual adjustments and measurements.

Much of the peripheral equipment is thus a very simple development over the previous manual gear—the hand switches and adjustments have been removed and replaced by relays.

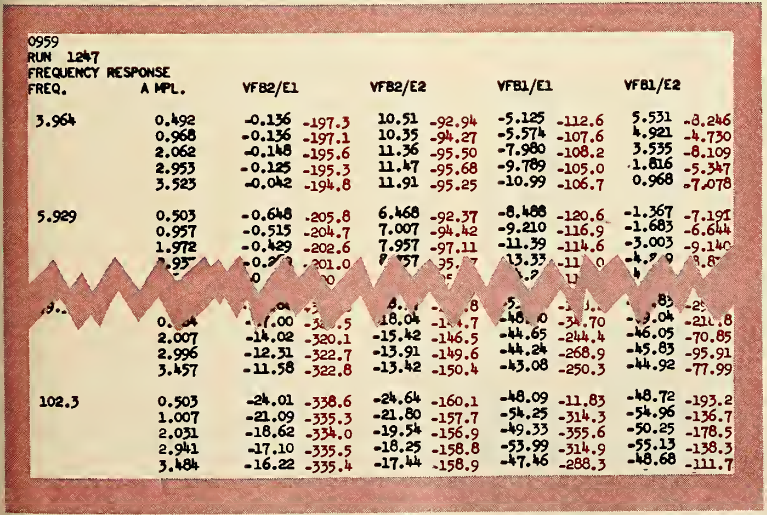
- **Programing and operation**—Programing the computer was of course a major work package. Sine waves are analyzed by a Fourier integral, insuring accurate measurement of the fundamental component even in the presence of noise and non-linear distortion. Other subroutines include such items as vector division, rectangular to polar conversion, set frequency and set amplitude. Setting routines are closed-loop—i.e., a measurement follows the adjustment and any errors are corrected.

All pheripheral equipment is thus calibrated against the analog-digital converter (in turn checked against a standard cell). Simple controls can be used, and no periodic calibration is needed.

The test engineer may specify any arbitrary frequency and amplitude. He chooses amplifier configuration, signals measured, and data to be printed.

The central computer may be connected to any one of ten test stations manually, with both local and remote switches for safety. While the test is running, the test engineer can watch on closed-circuit TV, and observe typed and plotted results. Additional data may be taken immediately, to follow up unusual results.

This real significance of the advances made by Douglas in improved service is that it has been achieved with conventional equipment—well within the state-of-the-art. It is efficient, has saved time and money; above all, the results are more accurate. ⌘



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0959
RUN  1247
FREQUENCY RESPONSE
FREQ.      A MPL.     VFB2/E1            VFB2/E2           VFB1/E1           VFB1/E2

 3.964     0.492      -0.136  -197.3     10.51  -92.94     -5.125  -112.6     5.531  -8.246
           0.968      -0.136  -197.1     10.35  -94.27     -5.574  -107.6     4.921  -4.730
           2.062      -0.148  -195.6     11.36  -95.50     -7.980  -108.2     3.535  -8.109
           2.953      -0.125  -195.3     11.47  -95.68     -9.789  -105.0     1.816  -5.347
           3.523      -0.042  -194.8     11.91  -95.25     -10.99  -106.7     0.968  -7.078

 5.929     0.503      -0.648  -205.8     6.468  -92.37     -8.488  -120.6     -1.367 -7.191
           0.957      -0.515  -204.7     7.007  -94.42     -9.210  -116.9     -1.683 -6.644
           1.972      -0.429  -202.6     7.957  -97.11     -11.39  -114.6     -3.003 -9.140
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           2.007      -14.02  -320.1     -15.42  -146.5    -44.65  -244.4     -46.05  -70.85
           2.996      -12.31  -322.7     -13.91  -149.6    -44.24  -268.9     -45.83  -95.91
           3.457      -11.58  -322.8     -13.42  -150.4    -43.08  -250.3     -44.92  -77.99

 102.3     0.503      -24.01  -338.6     -24.64  -160.1    -48.09  -11.83     -48.72  -193.2
           1.007      -21.09  -335.3     -21.80  -157.7    -54.25  -314.3     -54.96  -136.7
           2.031      -18.62  -334.0     -19.54  -156.9    -49.33  -355.6     -50.25  -178.5
           2.941      -17.10  -335.5     -18.25  -158.8    -53.99  -314.9     -55.13  -138.3
           3.484      -16.22  -335.4     -17.44  -158.9    -47.46  -288.3     -48.68  -111.7
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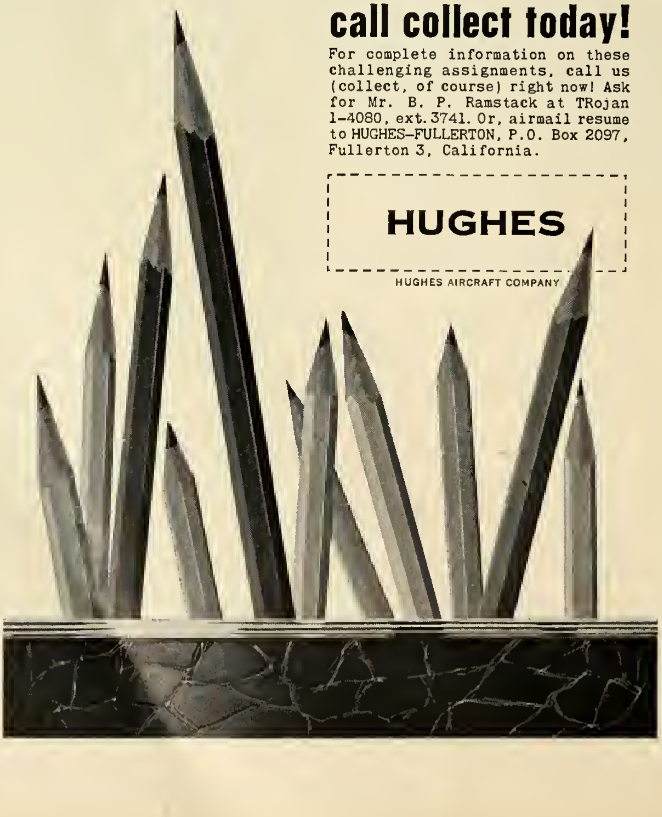

—contracts—

AIR FORCE

$201,902—Goodyear Aircraft Corp., for continued repair and maintenance of map synthesis equipment in the electronic guidance system of the TM-76A *Mace* missile.

NAVY

Lamtex Industries, Inc., Farmingdale, L.I., N.Y., for development and manufacture of rocket motor cases for the second-stage propulsion system on the *Polaris*.

$3,000,000—The Bendix Corp.'s Bendix-Pacific Div., N. Hollywood, Calif., for antisubmarine warfare sonar equipment.

$885,000—Vitro Electronics, Los Angeles, for a substantial portion of the systems engineering and instrumentation of two additional tracking ships assigned to the Pacific Missile Range Fleet.

$100,000—Instruments for Industry, Inc., Hicksville, L.I., N.Y., for transmitter system development. Subcontract from Sanders Associates, Inc.

ARMY

$1,223.600—Raytheon Co., Waltham, Mass., for four sets of *Hawk* ground support equipment.

$300,000—Hughes Aircraft Co., Culver City, Calif., for developing a guidance unit for the *Mauler* air defense system. Subcontract from Convair.

$300,000—The Eureka Williams Co., Bloomington, Ill., for production of fuses used in the 20 mm. conventional spotter rounds of the *Davy Crockett* weapon system.

$115,000—Giannini Controls Corp., Duante, Calif., for pressure transducers for the control system of the *Nike-Zeus*. Subcontract from Western Electric Co.

MISCELLANEOUS

General Dynamics Corp., New York City, has received a contract for "pulsing" atomic reactor designed especially to provide important data on the biomedical effects of nuclear radiation. Amount not disclosed.

General Mills, Minneapolis, for development of a manipulator system to be used in remote handling of rocket fuels and rocket motors. Subcontract from The Dow Chemical Co., Midland, Mich.

$1,200,000—Leventhal Electronic Products, Inc., Palo Alto, Calif., for a high-power tube-testing facility. Subcontract from Varian Associates.

$207,000—The York Body and Equipment Co., York, Pa., for electronic shelters. Subcontract from Raytheon Co.

NASA

Lockheed's Missiles and Space Division, Van Nuys, Calif., for design and building of a prototype sterilizing unit to insure that the first American lunar landing space vehicle will be germ-free when it hits the moon.

$500,000—General Electric Co.'s Defense System Dept., Syracuse, for high-precision radar display and computing equipment for use at the Flight Research Center, Edwards AFB, during tests of the *X-15*.

$84,000—Douglas Aircraft Co., for a comprehensive study of operations phases of a three-stage *Saturn C-2* system.

With its tremendous thrust, *Zeus* can intercept attacking missiles far from the area it defends

Zeus is designed for a hit every time on supersonic bull's-eyes!

At best, an anti-missile defense will have only a few minutes to react ... and no "second barrel" to fire at its supersonic target.

Nike Zeus needs none. Tests of this new anti-missile missile show that it will attack enemy ICBM's with 100% accuracy at a distant interception point. There its nuclear warhead will be detonated to blanket the approaching ICBM with an explosive curtain.

The newest member of the famous Douglas *Nike* family, *Zeus* was developed in a joint Western Electric, Bell Telephone, Douglas Aircraft project. Its design combines the most successful lessons learned from *Ajax* and *Hercules*—*Nike Zeus* predecessors that are on duty around many important U. S. cities and industrial centers and with NATO forces overseas.

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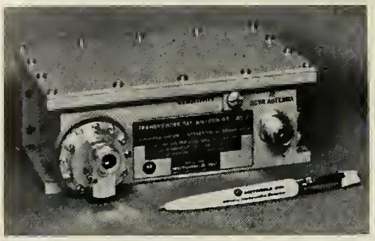

Radar Transponders

Two radar transponders, designed and developed by the Motorola Military Electronics Division, are available to missile and aerospace manufacturers for a wide range of tracking and range instrumentation applications.

The first unit, designated Motorola Type SST-101 (AN/DPN-63) is a general purpose, crystal-video transponder intended for use in tracking intermediate range missiles, drones and piloted aircraft.

The second unit, known as the Motorola SST-102 (AN/DPN-66), was developed for long-range missile tracking applications. It is a general purpose superheterodyne pulse transponder intended for use with precision C-Band tracking radars such as the AN/FPS-16 and AN/MPS-26 and features an all-solid state modulator switch.

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Synthetic Mica Paper

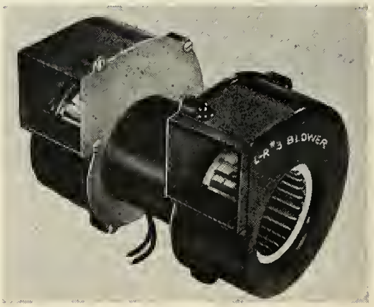
Synthetic mica paper is available from Synthetic Mica Co. in pilot plant quantities.

SYNTHAMICA 202 has a melting temperature of 1365°C and an operating temperature up to 1000°C. Electrical properties include a dielectric constant of 3-4 with a dissipation factor of 0.0005-0.0020, a dielectric strength of 600-1000 volts/mil and volume resistivity 5 x 10^{15} ohm/cm at room temperature.

Circle No. 226 on Subscriber Service Card.

Lightweight Dual Blower

A light weight Model 8481 Dual-Outlet Blower for heat dispersion has been added to the line of the Ripley Company Inc. The one-piece, impact resistant phenolic plastic housing with aluminum motor-plate is 6-3/8 in. from top to bottom. Total width of motor and blowers assembly is 7-3/4 in. Motor is 115 volts-60 cycles but 220 volts available on special order. The unit incorporates sealed ball bearings requiring no maintenance and operates in ambient temperature –34°C. to 93°C.



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L-Band Cavity Oscillator

General Communication Co. has available an L-band planar tube oscillator which is tunable from 920 to 1400 megacycles. A dual cavity with tuned plate and tuned cathode is controlled by a single leadscrew. The resulting single dial control covers the entire range with relatively small change in output level.

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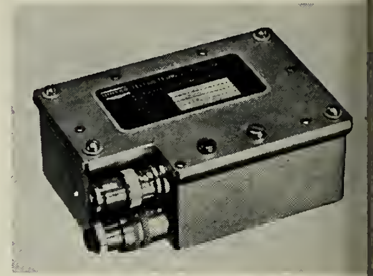

FM Telemetry Transmitter

A transistorized FM telemetry tran mitter is available from United Electr Dynamics, Inc. for the firm's FM/F and PCM systems. Specifications of th TR-10 include: 2.5 watts output wit true FM modulation over complete 21 265 mcs telemetry band; 99.9% relia bility for 500 hours; modulation fr quency response ±2 db from 3 cps t 300 KC; vibration-induced noise le than 1.5 KC deviation at 20 G's fro 20 cps to 2000 cps; and modulatio linearity less than 1% from straig line at 125 KC deviation.

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Stored Welding Power

A 100 watt-second stored energ welding power supply designed esp cially for the electronic compone packaging field has been developed b Hughes Aircraft Co.

Model VTW-30 delivers a step-fre adjustable range of power of 0.5 t 100 watt-seconds. A pulse width of le than 1.5 milliseconds assures no burnin or discoloration of the weld area an no heat damage to the componen being welded.

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Traveling Wave Tubes

Sylvania Electric Products Inc. marketing two temperature compe sated, magnetically shielded, travelin wave tubes, designed for "close qua ters" in airborne and missile applic tions.

The components (TW-4002F an TW-956H) employ periodic permane focusing and are designed for bo pulse and CW operation.

Both types operate without heat blankets from –65° to 72°C wi minimum performance degradatio They have a relatively flat frequen response over an octave, from 2.0 4.0 KMC. Each unit weighs approx mately 3 lbs., is about 15 in. long, a has a 1.4 in. capsule diameter.

Circle No. 231 on Subscriber Service Card.

Five European NATO nations will produce the U. S. Army Hawk missile as the primary ground-to-air defense weapon in Western Europe. Raytheon, developer and prime contractor in the U.S. for the Hawk, is supplying technical assistance to manufacturers selected by these NATO countries.

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names in the news

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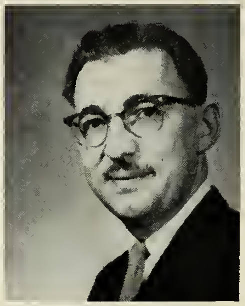
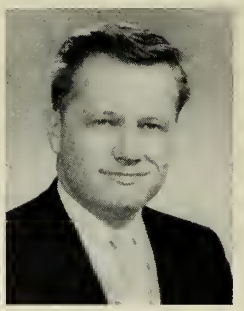

VAVOUDIS


WETZEL

Joseph Havrylak: Former manager of manufacturing for Aerojet-General Corp.'s Avionics Division, appointed Director of *Midas* programs within the division.

Lewis Bossert: Elected manager of magnetics marketing for The Wilcox Electric Co.'s Magnetics Division. He joined the firm two years ago as a design engineer.

Dr. Domenic Bitondo: Joins the Aerospace Corporation as manager of the Aeromechanics Dept. in the Systems Research and Planning Division. Previously held positions with STL, Northrop and the Aerophysics Development Corp.

William E. Ray: Appointed director of research for Dresser Products, Inc. Ray comes from Knolls Atomic Power Laboratory where he spent five years as a metallurgical consultant on submarine reactors.

William H. Otto: Former staff scientist with the Owens-Corning Fiberglas Corp., joins Narmco Industries, Inc. as a research specialist for the Research and Development Division.

Fred J. Wetzel: Named field engineer by Vitro Laboratories and transferred from the Silver Spring, Md., Laboratory to its Sunnyvale field office. He will conduct liaison with local *Polaris* contractors. Prior to this assignment, he participated in Vitro studies of shipboard missile handling, stowage and safety.

Joseph Rambusek: Former vice president in charge of sales for Bogue Electric Manufacturing Co., joins The Siegler Corp.'s Magnetic Amplifiers Div. as sales manager.

Sprague Electric Co. announces the following promotions within the company:

William J. Nolan, senior vice president in charge of legal affairs; **Neal W. Welch,** senior vice president, marketing and sales; **Wilbur A. Lazier,** senior vice president, technical director; **Robert C. Sprague, Jr.,** senior vice president, industrial relations; **David B. Peck,** vice president, special products; **Hollis R. Wagstaff,** vice president, fiscal; **Carroll G. Killen,** vice president, industrial and military sales; **Bruce R. Carlson,** vice president, corporate planning and systems.

Socrates N. Vavoudis: Former director of engineering for Itemlab Inc., joins United Aircraft Corp.'s Norden division as supervisor of the environmental laboratory. Prior to joining Itemlab he served in various engineering capacities with General Precision Laboratory and Electricoil Transformer Corp.

Dr. Erwin M. Koeritz: Appointed manager of manufacturing, Metallurgical Products Dept., General Electric Co., Detroit. Dr. Koeritz has been manager of manufacturing engineering in the firm's Silicone Products Dept. since 1956.

Edward L. Lavine: Formerly eastern regional sales manager of Ling Electronics, Inc., named vice president and general manager of Communication Measurements Laboratory, Inc.

B. A. Erickson: Former manager of flight and chief engineering test pilot in the B-58 supersonic bomber program at Convair-Fort Worth Division, promoted and given an executive special assignment in the office of the assistant manager for operations.

J. L. Bromberg: Appointed director of programs—Defense Programs for Douglas Aircraft Co. Was formerly program manager for the *Nike-Zeus* project and prior to that was one of the key members of the Air Force-industry team which developed the *Thor*.

Maj. Gen. Raymond C. Maude (USAF-ret.): Elected director of field operations for Philco Corp.'s Government and Industrial Group. Was formerly executive vice president of Internationa Electric Corp.

Dr. R. H. McFee: Former director of research for Aerojet-General Corp.'s Avionics Division, appointed director of research for the firm's Advanced Research and Products Division.

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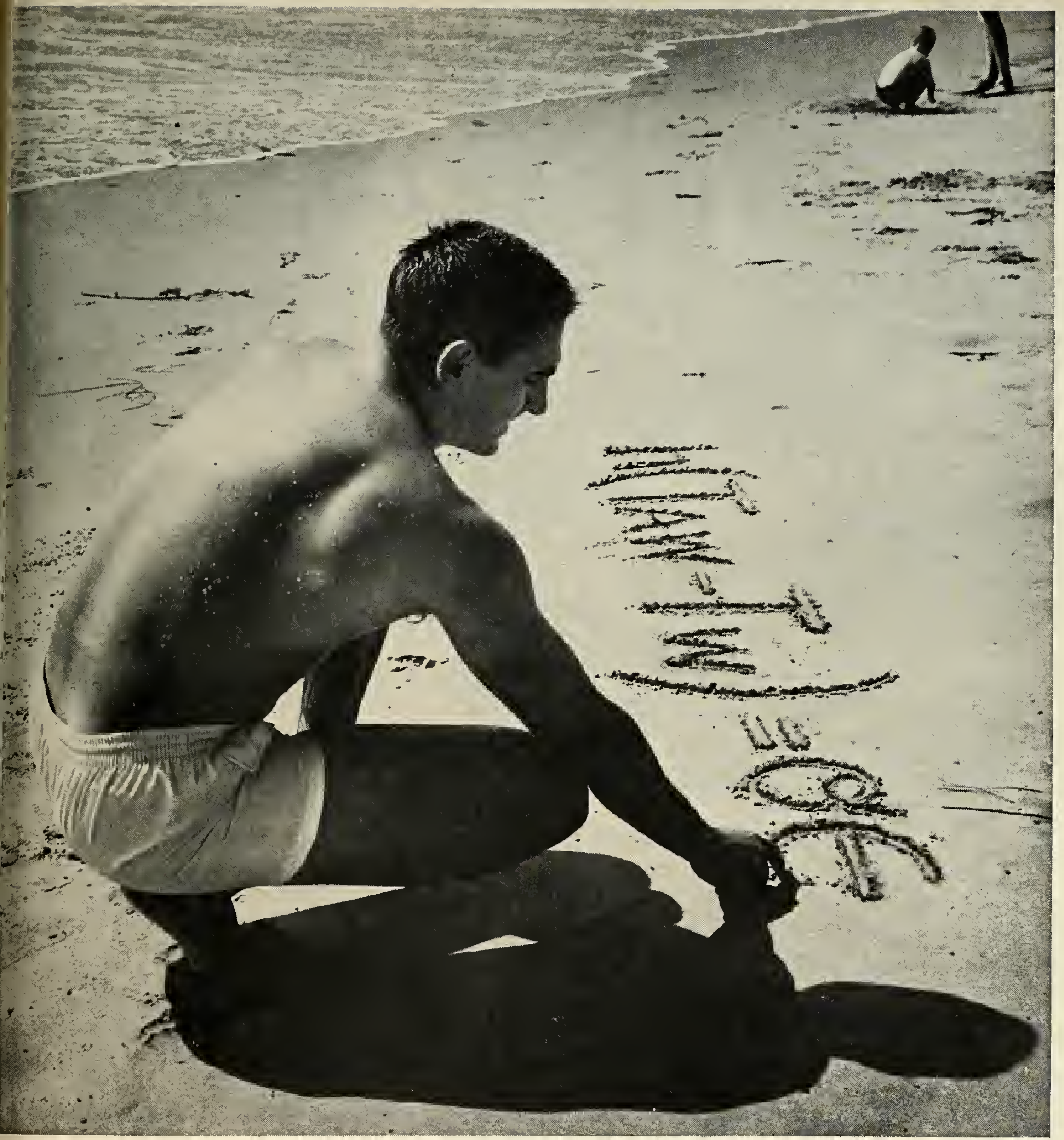

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Northrop Corporation, Box 1525, Beverly Hills, California

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LAUNCHING SYSTEM

READY WITH INSTANT, MASSIVE MISSILE POWER, 350-ton Guided Missile Launching System MK 12, designed and produced by General Electric's Ordnance Department, will triple the immediate fire power of TALOS missiles aboard the U.S. Navy's nuclear cruiser U.S.S. *Long Beach.*

IN A MATTER OF SECONDS, MK 12 automatically selects and hoists TALOS missiles from deep within the ship's magazine and rams them forward onto the launcher.

RIGID MK 12 supports 7650-pound, 33-foot long missiles and boosters, yet it is flexible enough to compensate for the twisting and turning of a ship at sea.

RESILIENT MK 12 prevents breakage of the relatively delicate TALOS missile while in motion, yet it is strong enough to provide tremendous acceleration rates.

COMPACT, FLAME-TIGHT, GAS-TIGHT missile magazine is made possible by novel articulating rack hoist drive which pushes missiles up from below the magazine doors instead of pulling the missiles up from above the doors.

FOR MORE INFORMATION on how the Department developed the articulating rack hoist drive, a key feature of the MK 12, write to Mr. L. A. Collins, Manager—Ordnance Sales, for the brochure, "Articulating Rack Hoist Drive."
166-14

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OF THE DEFENSE ELECTRONICS DIVISION

GENERAL ELECTRIC

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Exhibiting Our Space Achievements

SECRETARY OF STATE Christian Herter is not a man to write letters of commendation freely.

Yet he took the time recently to write such a letter commending the National Aeronautics and Space Administration team which conceived and put together a comprehensive space exhibit for the recently closed Montreal International Trade Fair.

The Secretary's letter didn't say so, but it indicated a growing realization on the part of State that our prestige abroad is clearly linked to our space achievements.

It also indicated the knowledge that while the Russians are ahead in spectacular—and certainly in strategic—space feats, some of ours are not so bad and that it is high time we told this fact to the world.

The Montreal exhibit was well-planned and well-executed. In language the layman could understand it told the facts of the American *Discoverer* series. *Tiros, Transit* and *Echo*. It was the most popular exhibit at the Fair and was seen by some 175,000 persons—including, incidentally, other exhibitors from France, Italy, Belgium, Japan and Mexico. The president of the Montreal Fair called it "the magnet which drew the crowds which made the fair successful."

The exhibit is now en route to Chicago, where in January it will be shown at the Chicago Museum of Science and Industry, with an expected draw of well over a million people.

Here, however, it may well end its exhibit life unless the Kennedy Administration recognizes the value of such demonstrations of American technical ability and makes provisions for their continuance.

There was no money in the 1961 NASA budget for the Montreal exhibit. Its cost was about $85,000 and the money was "scrounged" from any loose funds the Exhibit Branch of the Technical Information Office could find.

Future showings of this exhibit would cost simply transportation, although one exhibit won't stretch very far across the reaches of America. To build additional exhibits would cost probably half as much a copy as the original.

The 1962 NASA budget has, reportedly, about three-quarters of a million dollars for exhibits. If granted this will not be available until July, 1961; in any case, it is completely inadequate to the need.

NASA has received certain invitations to exhibits, including the British Columbia International Trade Fair in May and the American Rocket Society "Space Report to the Nation" in October, 1961. But it is not sure it can accept.

BEYOND THESE "DOMESTIC" opportunities, consider the educational influence such American space achievement exhibits would have in other parts of the world—in Africa, India and Indonesia.

The United States Information Agency (which has little or no money for such purposes either) could keep a dozen such exhibits on tour continually for months. Visual and easily comprehensive, these exhibits would do more, we believe, to successfully demonstrate U.S. space achievements and posture than any one other thing upon which we would spend equal money.

The State Department has taken one step in recognizing their importance. We most sincerely hope that State and USIA will help to present a case for them when the new Administration considers the budget, both supplemental and regular.

Clarke Newlon

Portrait of a Mach number

Air blasting across an aerodynamic shape at Mach 2 (above, left) records its image on film. In private industry's most extensive complex of wind tunnel installations, Boeing engineers and scientists are defining the shape of the future in supersonic and hypersonic flight. A new hypersonic tunnel, the nation's largest privately owned facility of its kind, tests up to Mach 27.

Boeing's emphasis on research and development of future advances covers a wide variety of fields, including missiles, satellites, space vehicles, anti-submarine warfare systems, hydrofoils, commercial and military aircraft, gas turbine engines, electronics, communication, propulsion systems, vertical and short take-off and landing aircraft.

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Expansion of advanced projects and systems management programs of the future has created openings at Boeing for professional specialists in scientific and engineering disciplines, and other, non-technical, areas of company activity. You'll find at Boeing a professional environment conducive to deeply rewarding achievement. Drop a note, mentioning degrees and major, to Mr. John C. Sanders, Boeing Airplane Company, P. O. Box 3822-MIK, Seattle 24, Washington.

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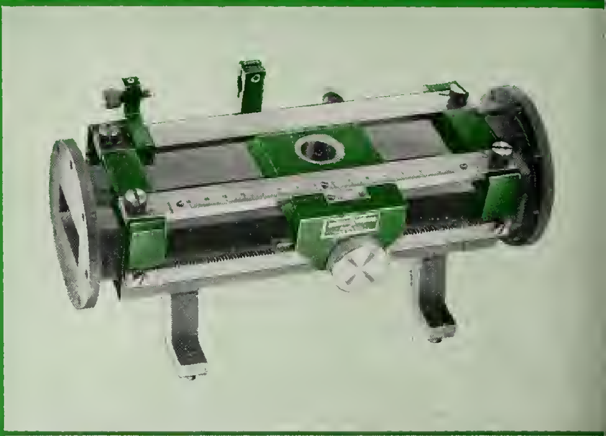

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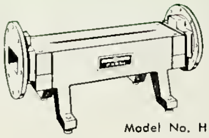

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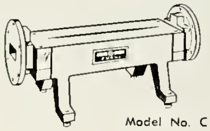

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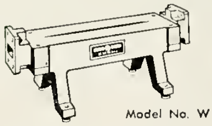

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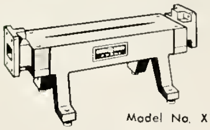

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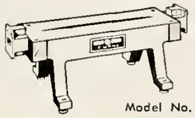

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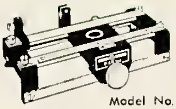
UNIVERSAL CARRIAGE



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C115A	5.85- 8.20	1½ x ¾	10⅜ in.	RG-50/U	UG-344/U
W115A	7.05-10.00	1¼ x ⅝	10⅜ in.	RG-51/U	UG-51/U
X115A	8.20-12.40	1 x ½	10⅜ in.	RG-52/U	UG-39/U
Y115A	12.40-18.00	0.622 x 0.311 ID	10⅜ in.	RG-91/U	UG-419/U

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DECEMBER 12, 1960

missiles and rockets

HE MISSILE/SPACE WEEKLY

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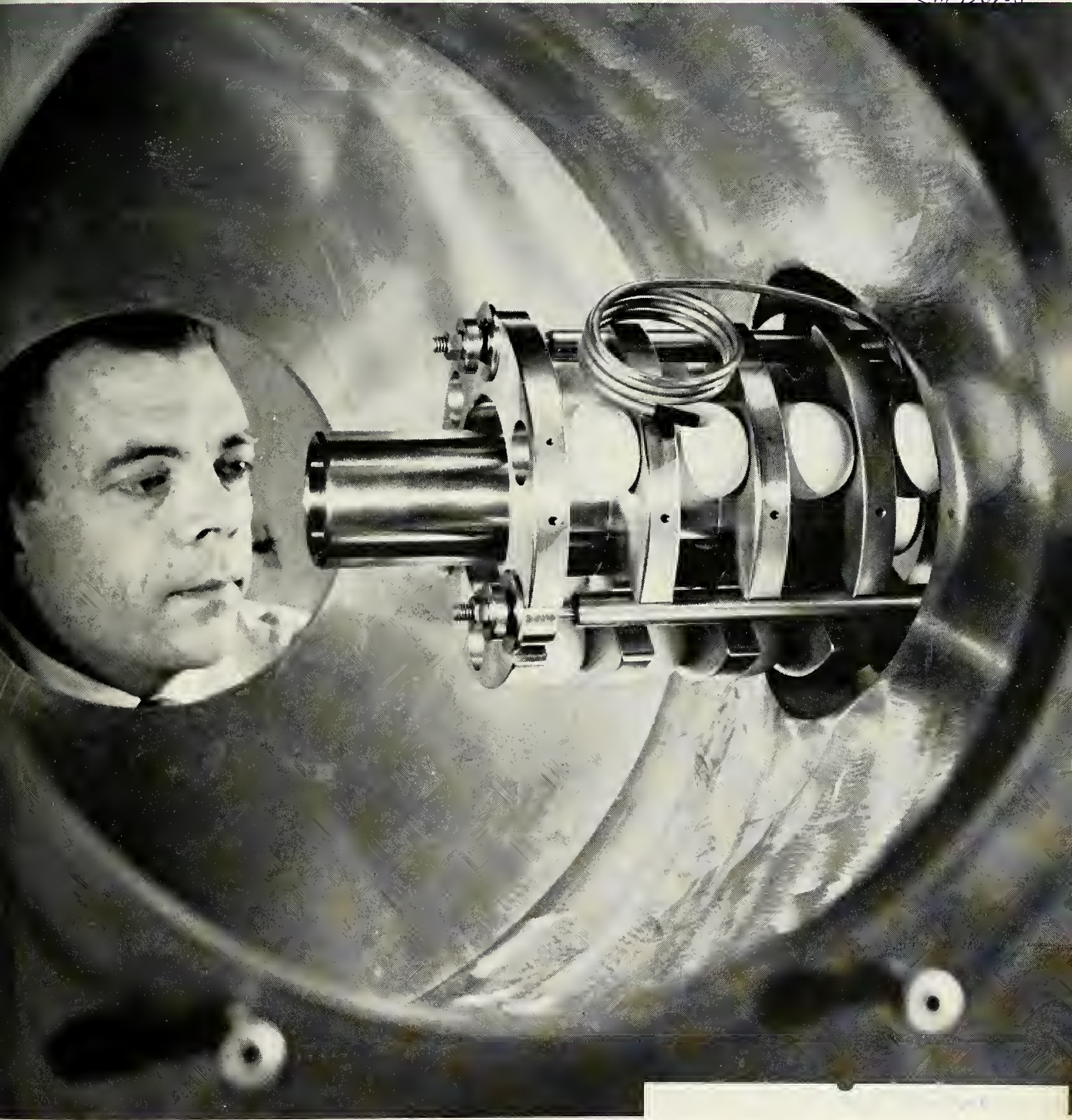

Ion Engine in Man-made Vacuum at Goodrich

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AN AMERICAN AVIATION PUBLICATION

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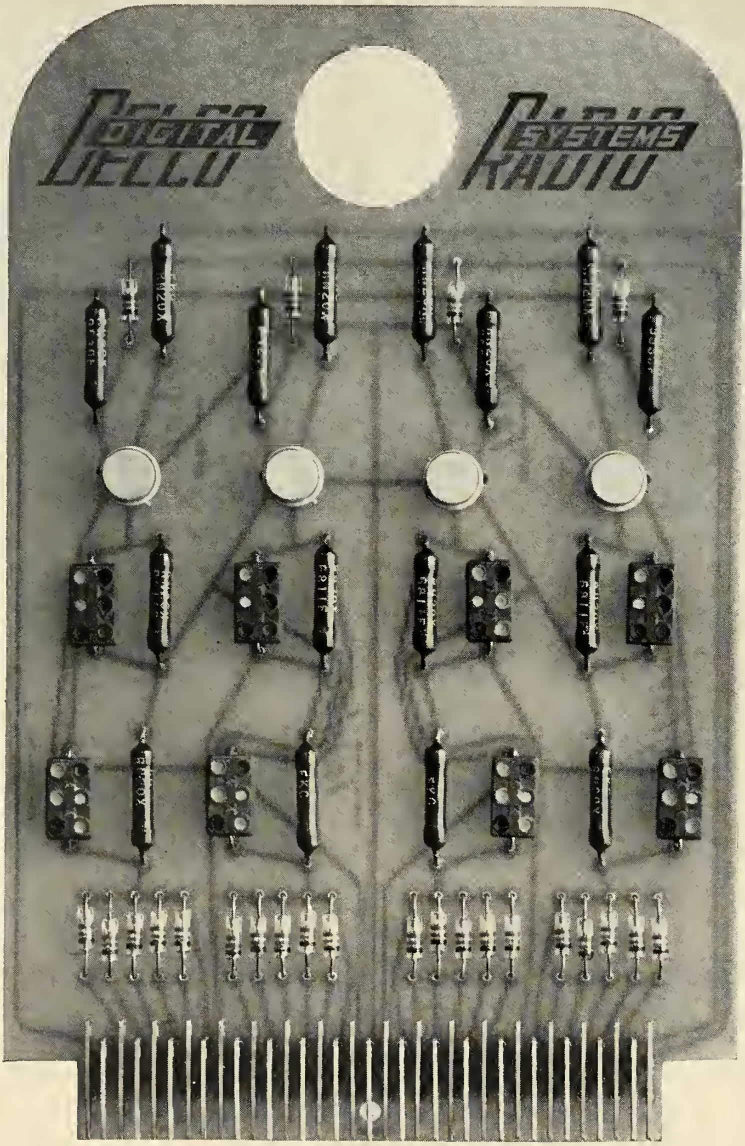

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THE MISSILE/SPACE WEEKLY

missiles and rockets

Volume 7, No. 24 December 12, 1960

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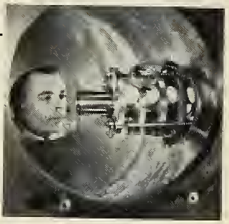
THE COVER



Ion engine is installed in vacuum tank at B. F. Goodrich Co. for test of performance under extra-terrestrial conditions. Engine was shown at annual ARS meeting last week.

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*U.S. Reg.
†U.S. Reg. Pdg.

31,975 copies this issue

—letters—

Russia and F.A.I.

To the Editor:

I have just received a copy of MISSILES AND ROCKETS for November 21, in which on page 35 there is an article concerning the new Regulations issued by the Fédération Aéronautique Internationale on the subject of record attempts in manned rockets.

I greatly regret to note the anti-Russian bias of your article, particularly the title. It may not matter to you or to your Paper whether or not offence is given to any country, but it does matter to our Federation in which the Russians, the Americans and all the other countries are Members with equal rights and equal obligations.

The rules to which you refer were agreed upon mutually by the Russian and U.S. delegates at our Conference. They were not devised for the purpose of obtaining secret information from the U.S.S.R. No one is obliged to register a record and, in fact, many performances are reported in the Press from time to time which appear to be superior to some of the existing records registered by the F.A.I.

We all know that Governments refuse to release technical details about the aircraft which have established these performances, but any person, organization or country which wishes to set up a record for registration by the F.A.I. knows that they must supply the information called for in the F.A.I. Sporting Codes. Therefore, there is no question of the Russians or anybody else being "put on the spot."

H. R. Gillman
Director General
Federation Aeronautique
Internationale
Paris

M/R's story did not say that the new F.A.I. regulations were drawn up with the intention of putting the U.S.S.R. on a spot. But don't they?—Ed.

Bullpup Numbers

To the Editor:

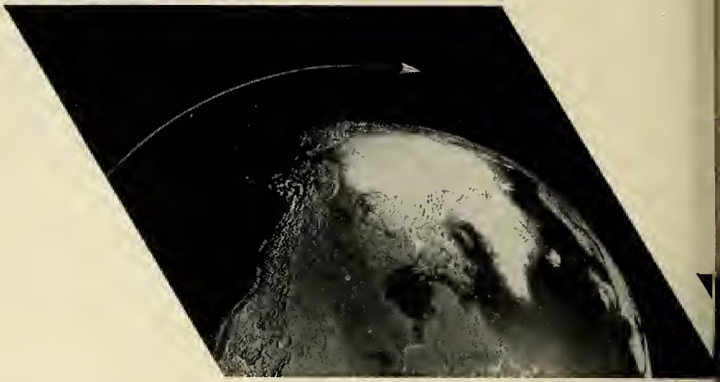
I noticed with interest the story in your issue of September 19, "Standardization Cuts Cost of Bullpup Support."

There was only one thing wrong with the ground support equipment story. In the first paragraph you refer to GAM 63. I know the missile business is a numbers game and that it was probably a typo, but the official designation is GAM 83. It is not an error of great importance and it is one of the rare ones your staff has made.

Thanks for your interest in Bullpup.

Julian Levine
Information Services
The Martin Co.
Orlando, Fla.

Engineers
Mathematicia
Physicists



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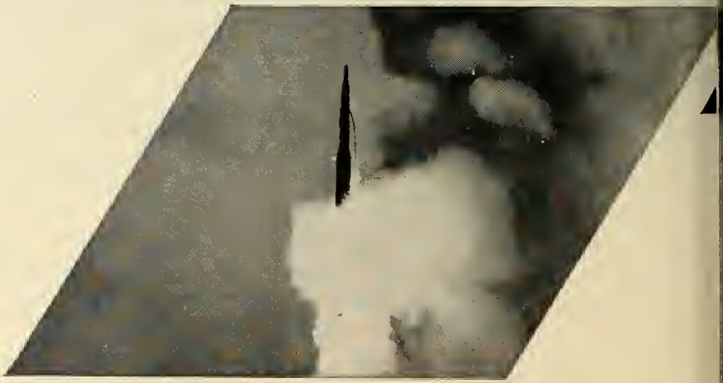

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Name ____________
LAST FIRST MIDDLE (USE NO INITIALS)

Social Security No. ____________

Present Address ____________
NO. STREET

____
CITY ZONE STATE

Telephone No. ____________

Ht. ______ Wt. ______ Age ______ U.S. Citizen ______

Male ______ Female ______ Marital Status ______

No. of Children ______ Other Dependents ______

U.S. Veteran ______ Entry Date ______

Discharge Date ____________

Type of Discharge ____________

Spouse's Maiden Name ____________

Employer ____________

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If the answer to following three questions is "yes," explain on supplementary sheet:

1) Have you any physical defects? ____________

2) Have you ever been arrested (except traffic and juvenile)? ____________

3) Have you ever received disability or accident compensation? ____________

TURN PAGE ➡

HIGHER EDUCATION

College and Location	Dates Attended	Degree and Major
1.		
2.		

EMPLOYMENT HISTORY

Firm Name and Address	Base Pay 40 hr/Wk	Dates Employed Month/Year
1.		
Position & Duties		
2.		
Position & Duties		
3.		
Position & Duties		
4.		
Position & Duties		

REFERENCES. Give full names, occupations and addresses.
Professional (previous supervisor preferred):

1.

2.

Character (other than relatives or former employers):

1.

2.

LIST TYPE OF WORK PREFERRED UPON EMPLOYMENT:

Have you ever been cleared for classified military information?________. If yes, give date, level and company.

May we contact your former and present employer prior to completion of employment negotiations? Yes____ No____
If "yes", I authorize, without liability, the release of all employment and personal information.

SIGN YOUR NAME HERE

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Application form begins on previous page.

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Seattle has the highest per-capita boat ownership in the country. Lake Washington, above, and other lakes are in the city. Seattle, in addition, is located on Puget Sound, which offers hundreds of miles of protected salt water for sailing, cruising, fishing. The Seattle area is famous, too, for fine modern homes, excellent educational and cultural institutions, and healthful outdoor Western living for the whole family.

BOEING

The Countdown

WASHINGTON

Fixing the Missile Pie

No amount of Pentagon reshuffling will eliminate one of the tougher decisions confronting President-elect Kennedy in January: the ICBM "mix." DOD planners are saying that 1961 is the year that the composition of the missile force must be determined for years to come. Commitments must be made on just how many ICBM's will be mobile and how many will be in fixed sites; whether there will be a large or nominal fleet of *Polaris* submarines; or just a few hundred *Minutemen* or more than a thousand. Otherwise the missiles won't be ready in the missile gap years 1963-64.

Targets vs. Targeters

Talk of "reducing" the number of Soviet targets is considered by those on the inside to be highly erroneous. Actually it's the other way around. The targets remain the same. But what joint target planners are trying to do is cut down on duplication by unified commands who have assigned themselves many of the same places to hit in wartime.

ICBM Unit Costs Rise

Latest Air Force ICBM price list puts a $13.7-million tag on one ready-to-shoot *Atlas* in a 1 by 12 hardened and dispersed squadron configuration. *Minuteman* per silo now is pegged at $3.4 million (up $1.4 million from previous estimates). R&D is prorated in both price figures.

Army/NASA High Altitude Research

Electron density and other physical properties above 700 miles will be investigated jointly by the Army's Ballistic Research Laboratory, Aberdeen, Md., and NASA. BRL, which has dropped the *Strongarm* sounding rocket, will design the payloads to go aboard NASA's *Argo D-8* for the probes.

Underwater Intelligence

Navymen are wondering if they can keep tests of a new one-million watt underwater transmitter secret. The transmitter is going aboard a converted freighter, reportedly as part of the *Artemis* ASW project. The secrecy problem: testing the transmitter is expected to "kill one helluva lot of fish."

INDUSTRY

Dyna-Soar: Off-shelf Guidance?

COUNTDOWN is told that the Air Force is shopping hard for an off-the-shelf guidance system for *Dyna-Soar*. This has considerably broadened competition for the soon-to-be-let contract. AF apparently is intent upon moving to test flights as soon as possible.

Polaris Production

Talk is dying of a second source for *Polaris* missile fire control. GE has the contract and is said to have the production capacity to meet present submarine construction schedules. However, missile production schedules are forcing the Navy to go to more than one source. One of the big tussles to be decided soon is whether GE or Raytheon will get the guidance system contract for the 2500-mile *Super Polaris.*

Aerospace Corp.'s Plant

For those who have been wondering, the AF tells COUNTDOWN that the financial history of Aerospace Corp.'s new plant in El Segundo, Calif., goes like this: Ramo Wooldridge built the plant. Space Technology Laboratories then acquired it. The AF is paying STL for the facility.

Mahogany Row

North American President J. L. Atwood is now chief executive of the company, taking over from Board Chairman J. H. (Dutch) Kindelberger who will keep his title but devote his time to policy and planning . . . Sanders Associates, Nashua, N.H., electronic firm, is moving its Navy *Eagle* air-to-air missile target-seeking work to a new plant on Boston's Route 128—the "Golden Semi-Circle."

Boeing Earnings Up

With 30% of its business in missiles, Boeing Airplane Co. estimates 1961 earnings of about $4 per share—up from this year's estimated $2.75-$3 . . . Space Recovery Systems of Los Angeles, jointly owned by Steinthal & Co. and CBS Laboratories is being purchased by Itek Corp . . . and Bendix Corp. is continuing its expansion plans with the acquisition of Micrometrical Mfg. of Ann Arbor, Mich.

Davy Crockett's Weakness

Army brass is said to be worried over possible unwarranted or premature use by infantry of its portable *Davy Crockett* missile, which is nuclear-tipped. They feel some sort of "positive control" is needed without destroying the effectiveness of the weapon as a "handy" item. Just what the answer will be isn't apparent.

INTERNATIONAL

Sylvania Taking Over Thorn?

Rumors buzzing through London financial circles have U.S. Sylvania making a bid to take over Thorn Electrical Industries, one of Britain's biggest electronic firms. Thorn is denying it, but . . .

Scout Abroad

NASA is negotiating with France, Germany, Italy, Japan and Australia to put their instrumentation in *Scout*-launched satellites. Discussions are also in progress with Norway, Sweden and Argentina. But so far the only firm agreements are with the United Kingdom and Canada.

Soviet Foot-dragging

Russia is still holding up formation of the U.N. Committee on Peaceful Uses of Outer Space (M/R, Oct. 24, p. 12). However, Secretary General Hammarskjold is said to be trying to force the issue to a head in the next few weeks. Set up in 1959, the committee has yet to hold a meeting.

Overseas Pipeline

Some British scientists are pushing for a satellite launch vehicle composed of a *Blue Streak-Black Knight* with a LOX-liquid hydrogen third stage. But there is still no indication whether the government will commit itself to a space program . . . The British Admiralty has ordered *Sidewinders* for its Scimitar fighters . . . *Paris Match* reports the return of French Naval Secretary Le Bigot from a U.S. visit of *Polaris* missile and submarine research and production centers.

The Missile/Space Week

Elevator Seen as Possible Cause of Titan Blast

A possible failure in the elevator mechanism or human failure appears to have caused the blast that ripped the *Titan* R&D launching silo at Vandenberg AFB during a missile loading test this last week.

There was no immediate determination on what effect the accident would have on the *Titan* program. However, Air Force officials expressed the hope that the first *Titan* squadron will still be operational on schedule in mid-1961

The explosion occurred when a fueled *Titan* was being lowered into the silo by the giant elevator. The big missile was halfway in when it suddenly appeared to drop the rest of the way. Flames spouting from the silo could be seen for miles; the blast was felt 20 miles away.

There was speculation that someone may have punched the wrong button

Damage to the silo was so great that it was generally considered a total loss. A four-level underground equipment terminal and an underground propellant terminal some 40 feet on either side of the silo were reported to be wrecked.

However, there is a second *Titan* silo complex at Vandenberg available for test launchings.

Polaris, X-15 and Snark

Polaris II is nearing the day when it will reach out 1500 nautical miles. The second Lockheed R&D *Polaris II* to be launched roared 1400 nautical miles down the Atlantic Missile Range Dec. 5.

The Air Force said farewell to the *Snark* R&D program the same day. The last Northrop R&D *Snark* flew 5000 miles over the Atlantic.

Test Pilot Scott Crossfield successfully flew the *X-15* with its powerful new XLR-99 engine for the third time Dec. 6. The rocket plane roared across the California desert at full power some 10 miles at about 60,000 feet.

France To Join 'Nuclear Club'

The French Assembly approved President De Gaulle's plan to build a French nuclear striking force of bombers and missiles. The action came less than two weeks before the NATO conference on creating a separate NATO nuclear force.

SCOUT launching fails . . .

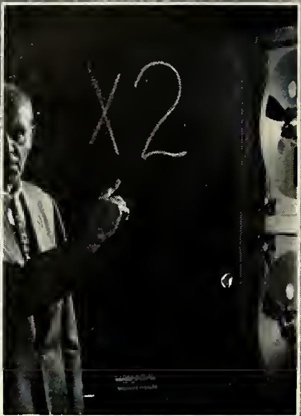
NASA Faces Schedule Quandary

A backup payload is available for another attempt at orbiting a "baby *Echo*" air-density drag satellite with the next *Scout* launch vehicle test early in 1961.

Scout-3, the first orbital attempt with the low-cost all-solid vehicle and the first attempted satellite firing from NASA's Wallops Island station, failed to orbit Dec. 4 when the second stage either failed to ignite or did not receive the signal to ignite.

The vehicle plunged into the Atlantic about 80 miles downrange. It was the first failure in dozens of firings for the second-stage *Castor,* a Thiokol motor similar to the Army's *Sergeant.*

The NASA schedule calls for launching *S-55,* a micrometeorite measuring satellite, with the next *Scout* in early 1961. *Scout-5,* programed for the second quarter of the year, is a backup vehicle. The question now is whether to juggle *S-55* and the backup air-density balloon.



How to double performance of your magnetic tape recorders

Now you can record 125-kc data at 30 ips instead of 60 on most existing data recorders. How? By using the new Ampex FR-600 for playback. New record/playback capability in the FR-600 saves previous equipment from obsolescence with some added benefits of its own—for example, recording 500 kc at 120 ips.

Your curiosity whetted? Write:

AMPEX

AMPEX DATA PRODUCTS COMPANY
Box 5000 Redwood City, California

Circle No. 10 on Subscriber Service Card.

ozenth Discoverer Orbited

The Air Force on Dec. 7—the 19th anniversary of Pearl Harbor—sucessfully launched *Discoverer XVIII* into a polar orbit and prepared to tempt a retrieval off Hawaii. The 2100-lb. satellite, twelfth in the series to into orbit, had an apogee of 450 miles and a perigee of 150 miles. It was owered at takeoff by a *Thor* with a 165,000-lb.-thrust engine, souped up eyond the previous 150,000 lbs. An *Agena* second-stage gave it its final kick.

The Air Force declined to say whether the satellite carried any "sky spy" meras or other surveillance equipment. They did announce that its recoverle 300-lb. capsule carried human bone marrow, blood cells and a memrane from a human eyelid to check the effects of radiation on man.

inde Will Make NASA's Liquid Hydrogen

Linde Co. division of Union Carbide last week won a sharply contested 31-million contract for supplying NASA with up to 60 million lbs. of liquid ydrogen through 1966.

Linde will build a new plant at Fontana, Calif., which will go into producon in mid-1962. Until then Linde will supply transportation of NASA eeds in liquid hydrogen on the West Coast from the Air Force plant at est Palm Beach, Fla., operated by Air Products Inc.

All of the liquid covered by the contract, signed Monday afternoon, will upplement an estimated 3.3 million lbs. produced by a Linde plant opened st summer at Torrance, Calif.

Air Products and Shell Chemical Co. were the other bidders.

putnik 'Failure' in Perspective

Biomedical leaders meeting in Washington, D.C. reiterated the opinion at the USSR may be at least 3 to 5 years ahead of the United States in utting living systems into orbit, in spite of the recent Soviet *Sputnik's* hapless te. The five-ton spaceship, heaviest vehicle ever orbited, carried two dogs nd numerous other biological experiments destined to predict the effects of pace travel on man. The vehicle apparently malfunctioned during re-entry and disintegrated in the atmosphere. Presumably the ship was to slow down, eject the biomedical capsule, then land itself as *Sputnik V* was supposed to have done. Trackers estimated that the ship made 17 or 18 passes in an elliptical orbit 115 miles at perigee, 164 miles at apogee at an inclination of 65°.

Zeus Passes Test

UIDANCE of the Nike-Zeus A-CBM checked out successfully in s first test shot on Dec. 1 at the hite Sands Missile Range. Army s now pressing for "interim prouction" of the defense weapon.

Disarmament a Bogeyman?

Disarmament would not topple the defense industry, Martin Co. president William B. Bergen told the New York Society of Security Analysts. As much or more business could develop for space projects, with programs such as *Apollo* coming in line for extra support. In another burst of independence, General Electric announced plans to start exploration and economic development of space without government contracts. However, President Ralph J. Cordiner made it clear that GE had no specific space project that could run by itself now, and government contracts would keep GE's resources occupied at least two or three years.

NORD-AVIATION
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SS-11 MISSILE
ONE MAN TANK KILLER

Nord's SS-11 is the only anti-tank missile with a warhead able not only to pierce, but to destroy and smash, any existing tank. Effective ground-to-ground or air-to-ground, the SS-11 can be launched by one man. Accurate between 800 and 3,600 yards, the SS-11 speeds to its target at 425 m.p.h. Operational for 3 years.

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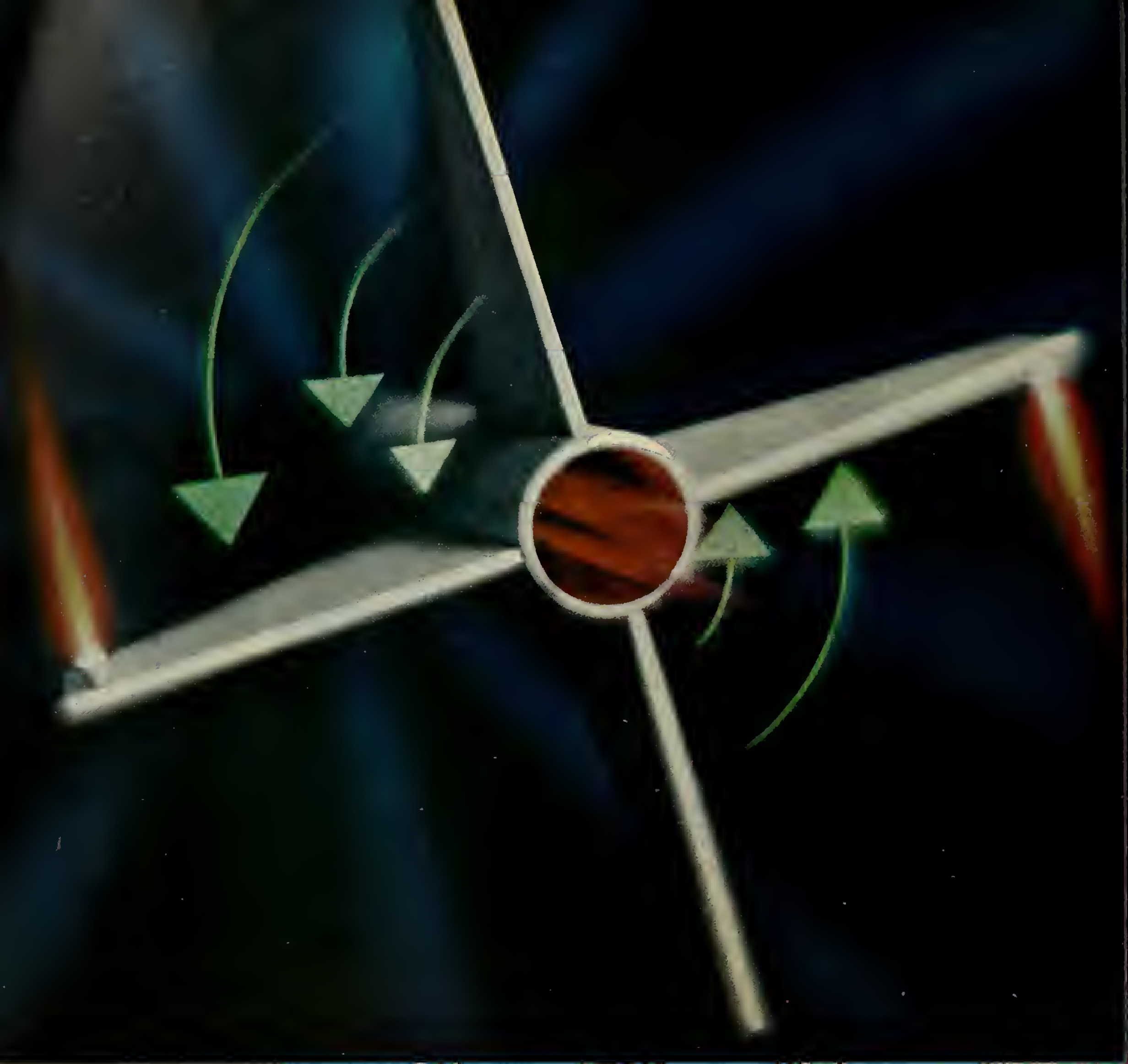

Reaction controls at work in space — symbolized.

STEERING GEAR FOR ASTRONAUTS

Conventional aircraft control surfaces will not guide space ships and capsules. Rudders, ailerons and elevators find no resistance and hence produce no reaction to their movements where there is no atmosphere. Even at altitudes only half way up, they are sluggishly ineffective.

The accepted answer to a dependable steering mechanism for astronauts is a system of jet reaction controls developed and produced by Bell Aerosystems Company. First used on Bell's own supersonic X-1B several years ago, the system has been greatly improved and adopted for the X-15, the Mercury man-in-space project and other space vehicles.

Through strategically located, low and high thrust (1 to 1500 pound) rocket engines, Bell's reaction controls not only position and guide the ship by controlling the roll, pitch and yaw, but they also provide for orbit changes and retro-thrust. Some of the jets are throttleable while others can be operated in combination to provide the astronaut positive and flexible control.

This revolutionary steering gear for space, available using monopropellants or high energy bipropellants, is just one of many advanced projects which are currently engaging the diversified talents of Bell Aerosystems Company in the fields of rocketry, avionics and space techniques. Engineers and scientists seeking challenging, long-range career opportunities can find them at Bell.

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Cuban Incident . . .

New Look at Launch Ships

Diplomats aid fight for 'pads' at sea

by James Baar

THE NAVY'S PROPOSED satellite launching ship—shelved by the Administration's still-secret final budget—is picking up strong new support because of the recent rain of U.S. rocket fragments on eastern Cuba.

The State Department appears to be pressing the Pentagon to find some way to avoid launching rockets from Cape Canaveral in trajectories that pass over Castro's Red-dominated island.

At the same time, proponents of the satellite launching ship are understood to have begun a new drive in the Pentagon to squeeze the $30-million program into the Navy's tight new budget for FY 1962. They are arguing that the ship is needed not only for R&D work but as the operational platform for a spacecraft interceptor weapon system.

• Charges stir 'concern'—The rocket fragments fell on an uninhabited area of Cuba after a *Thor AbleStar* carrying the *Transit IIIA* navigation satellite was destroyed by a safety officer shortly after the booster was launched Nov. 30 from Cape Canaveral. The *Thor AbleStar's* planned trajectory passed over Cuban territory.

Revolucion, the official mouthpiece of Castro's revolutionary organization, said: "This is a new Yankee provocation, a new demonstration of the contempt of the Pentagon military for the life and security of other people."

The State Department, in discussing the incident with the Pentagon, is reported to have taken the position that:

–If fragments from another U.S. missile should cause damage in Cuba, the Castro propaganda machine could whip up more anti-U.S. sentiment in Latin America and cause other difficulties.

–The Pentagon should stop launching rockets over Cuba if at all possible.

So far, the Pentagon has declined to comment beyond stating that an investigation is underway and that Pentagon officials are "concerned."

Asked if the United States were considering cessation of rocket launchings over Cuba, a Pentagon spokesman said: "We have nothing to add to what we said earlier."

• A second look—However, behind the scenes, officials were taking a new look at Navy proposals for seaborne missile pads including the launching ship.

Earlier, the Navy specifically considered including the first of possibly two satellite-launching ships in the FY '62 budget (M/R, Aug. 1). However, the proposal was dropped by the Navy in favor of squeezing other items considered to have higher priority under the tight budget ceiling lowered by the outgoing Eisenhower Administration.

The ship probably would be a converted Curritick Class seaplane tender. Cost of converting the 9000-ton ship and equipping it is estimated at about $30 million.

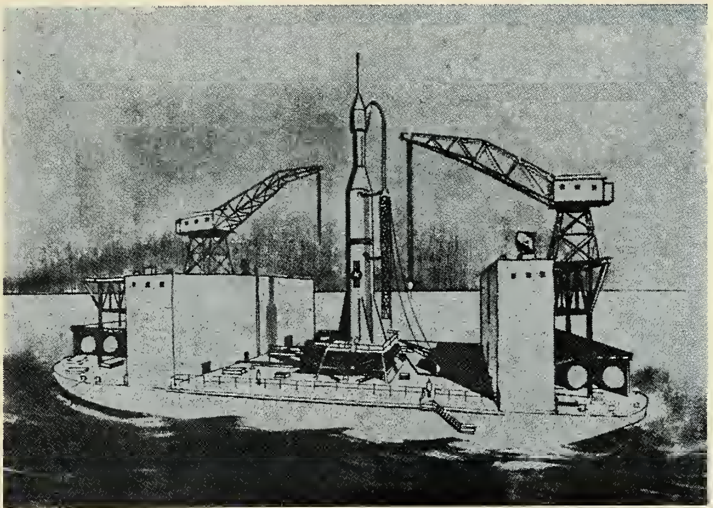
The ship would be a mobile miniature Cape Canaveral capable of launching boosters with up to about 200 lbs. of payload. One of its first assignments would be the launching of the Navy's *Transit* navigation satellites. However, it also could be used as part of a task force to launch anti-satellite missiles.

The cost of a mobile launching ship compares favorably with the cost of constructing similar land-based facilities. The construction of what is described as an "austere" R&D launching pad complex for an *Atlas* is officially estimated at about $40 to $50 million. A similar *Thor* complex for launching satellites is estimated at slightly less.

• Drydocks available—Besides the proposed launching ship, the Navy also has been considering proposals for constructing seaborne launching pads for much bigger boosters by converting floating drydocks.

The drydocks—placed in mothballs after World War II—could be used separately or joined together, depending on the size of the boosters involved. The docks could be towed to any sheltered water in the world to provide mobile equatorial launching sites.

Both the satellite ship and the floating dry dock would give the United States the capability of launching payloads into any desired orbit without launching over U.S. or foreign soil or paying the severe, costly penalty of dog-legging trajectories with restartable rocket engines. ⌘



MOBILE LAUNCHING PADS like this one conceived by Daniel, Mann, Johnson & Mendenhall can be constructed from the Navy's mothballed floating drydocks.

ARS Meeting

Advance Into Space Seen Major U.S. Goal

Speaker blasts policies of Defense and Industry alike; Von Karman heads list of annual award winners

CLEARLY THE NEXT ADMINISTRATION must make the conquest of space a major national goal.

This course was laid down before the 15th annual American Rocket Society meeting in Washington last week by peppery Dr. Abe M. Arem, who challenged the Kennedy Administration to tell the reasons for this goal "loudly enough to gain the support of every U.S. citizen."

Zarem, president of Electro-Optical Systems being suggested as the next head of NASA, methodically scorched:

–DOD for "wasting creative talent" in industry by its procurement policies.

–Industry for failing to "change its ways from progress by inches to progress by miles."

Denouncing American industry as "fat and lazy," the short and hefty ARS director said "research . . . is not seen in its true light as a creator of knowledge, wealth and power."

DOD's procurement system, he said, "is like a gigantic bowl of wet noodles. Trying to get something done is like pushing one end of any of the noodles. No one knows where the noodle is connected—where it goes in the mess—and what if anything will move."

• **Manned satellites**—A large number of papers read at the meeting stressed the need for manned orbital rendezvous if we are to put a man on the moon by the early 1970's. Space rendezvous attempts could be made with unmanned craft in 1961 or 1962, one scientist said, but it will be 1964 before manned craft will be able to meet in space.

International space laws, too, must be formulated in the next few years, to go along with the expected rise in space activity. Although it's too early for a detailed and comprehensive code to govern the use of outer space, according to a report made to NASA by the American Bar Foundation, sooner or later space law must face the problem of rights and prohibitions.

House Space Committee Special Counsel S. M. Beresford told the meeting that there may be as many as 50,000 space launchings by 1975 and that nations must get together on rules governing liability for injury or damage caused by launchings.

Besides technical presentations, other speakers covered more mundane subjects. One innovation this year was the inclusion of two days of panels devoted to marketing, advertising, and public relations in the Space Age. Included in this was a warning to aircraft manufacturers that they must concentrate on areas of the military market that are destined to grow, maintain systems management capability, and expand their marketing horizons.

The space field's highest honor—the ARS Robert H. Goddard Memorial Award—was presented at the annual banquet to Dr. Theodore Von Karman, pioneer in aeronautical and astronautical research and chairman of the NATO Advisory Group for Aeronautical Research and Development.

Other awards presented:

- **ARS Propulsion Award**—Dr. Ernst Stuhlinger, supervisory physical chemist, NASA Marshall Space Flight Center, for his work in rocket power.
- **James H. Wyld Memorial Award**—Robert L. Johnson, chief engineer, Douglas Aircraft, Missiles and Space Engineering dept., for contributions to *Thor* IRBM development.
- **G. Edward Pendray Award**—Prof. Luigi Crocco, Princeton University, for outstanding contributions to rocketry and astronautics literature.
- **ARS Astronautics Award**—Scott Crossfield, pilot-engineer of *X-15*, for achievements in manned space-flight.
- **ARS Chrysler Award**—Julian I. Palmore, Cornell University student, for his paper on a lunar impact probe.
- **ARS Thiokol Graduate Student Award**—Richard J. Hayes, James M. Glassmeyer, and Charles A. Huebner, MIT graduate students, for their paper on the duo-plasmatron ion rocket.

Goodrich - High Voltage Astronautics exhibited a model of an ion engine and electrostatic generator which has produced thrusts of 10-multipounds with an isp range of 10,000 seconds and a power efficiency in excess of 90%.

Aerojet-General Nucleonics announced production of hydrozine by "fissio-chemistry" in a nuclear reactor.

Westinghouse released the first information on its "thermally activated ceramic/metal combinations" which, when heated, produce an electrical output. Research is aimed at a 5-10 lb. per kwh unit.

Over 3500 scientists, engineers and technical personnel registered for the technical sessions this year. Some 163 papers were presented in 35 different sessions. An additional 2000 people visited the Astronautical exhibition.

Technical Highlights

- ***All-solid "modular" rockets for quicker and cheaper space missions***
- ***Commercial Communications satellites ready for launch within year***
- ***New sodium/lithium engine for underwater propulsion***
- ***Saturn GSE ready to go despite problems***
- ***Minuteman silo launch test phase ahead of schedule***
- ***Composites can meet demands for high-temperature materials***
- ***New techniques for space guidance***

(See page 35 for resumes of these and other significant papers.)

Sweeping Defense Changes Proposed

by Clarke Newlon

EXTENT OF the Kennedy Administration's efforts to lift the U.S. military organization from the concepts of World Wars I and II into the Space Age may depend upon how much of a proposed reorganization can be accomplished by executive order and how nuch will require Congressional action.

Conclusions of the Symington Committee handed to the president-elect last week call for sweeping alterations in the military structure. They would entail major legislative and executive changes. The changes, most of them orecast by M/R (Nov. 14 issue, p. 8), nclude:

–Elimination of the present departmental structure of the Army, Navy and Air Force, while preserving he Services as separate units within a single Defense Department.

–Elimination of Service Secretaries, ıssistant and under-secretaries—15 in ıll.

–Abolition of seven existing offices of Assistant Secretary of Defense.

–Creation of two new Under Secretaries of Defense, one for Weapon Systems and one for Administration.

–Creation of a Special Assistant to he Secretary of Defense for Arms Control, to serve as liaison in that area with he State Department.

–Reconstitution of the Chairman of the Joint Chiefs as Chairman of the oint Staff, making him chief military ıdvisor to the Secretary and, in effect, he chief military officer of the nation.

–Establishment of a Military Advisory Council composed of senior officers of all Services, to be appointed by the President. These officers would ıave no responsibilities to their own ervices and would not return to their own services. The Chairman of the oint Staff would preside over the Council.

–Redesignation of the Service Chiefs s responsible for support of unified ommands. Chiefs would not serve on ither the Joint Staff or the Council.

–Establishment of the following ınified commands:

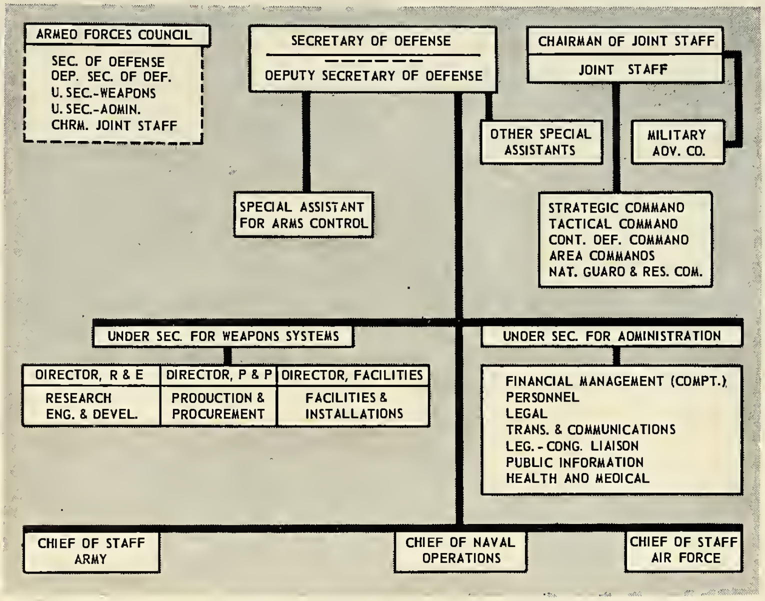
1. A Strategic Command, reponsible for all strategic missions.

2. A Tactical Command, reponsible for all limited and conventional defense missions.

3. A Defense Command, responsible for all continental defense missions.

4. Certain Area Commands (such as Pacific or Atlantic) as needed.

5. A command in charge of the National Guard and Reserve elements of all Services and responsible for Civil Defense.



SYMINGTON COMMITTEE which drew up defense reorginazation recommendations for President-elect Kennedy submitted this chart illustrating proposed structure.

• **'Piecemeal' efforts scored**—The National Defense Act which established the Department of Defense was passed in 1947. It was amended in 1949, put through a major reorganization in 1953, and amended again in 1959.

The Symington Committee, composed of the Missouri Senator and five former government officials (three from the DOD) and named by Mr. Kennedy after his nomination, pointed out, however:

"The piecemeal amendments . . . did not alter the essential character of the U.S. military organization, deployed on the basis of whether a military man travels on land, sea or air. Hence it can be truly said that since 1947 there has been no fundamental change in the scheme of organization of our armed forces.

"Yet during this period of nearly a decade and a half, the whole state of the art in military science has been revolutionized, as epitomized in the transitions to the jet, nuclear and space ages."

• **Trouble in sight**—While the committee was saying in effect, "don't try to prepare for the next war on the basis of the last," most Capital observers nevertheless felt that some of the proposed changes would be opposed by many Congressional leaders, and military officials, for that matter.

How much of the National Defense Act would have to be further amended is a much-discussed question. A new President, for instance, could abolish Service Secretaries by simply not appointing them. This would bring up the difficulty that the Service Secretaries have to approve all Service procurement. Other changes which might be made by Presidential order could conceivably run into Congressional withholding of funds.

Most likely to happen: a compromise which would abolish many of the Pentagon's civilian layers and go much further than the Servces yet have gone in joint or unified commands; upgrading the power of the Secretary of Defense and the Chairman of the Joint Chiefs—but providing no single Chief of Staff. ⌗

Kennedy Should Put Civil Defense unde

An expert hails reorganization proposal as the only realistic hope for survival, calls for home shelters

by Pat Frank

THE SYMINGTON COMMITTEE PLAN to establish a separate military command responsible for Civil Defense is designed to give the people of the United States a real chance for survival in the event of nuclear war.

The Command, which would absorb the National Guard and Reserve elements of all three services, is intended to have equal stature with other major commands—including Strategic and Tactical.

It would, in effect, make the National Guard and Reserve units responsible for Civil Defense under direction from the Pentagon.

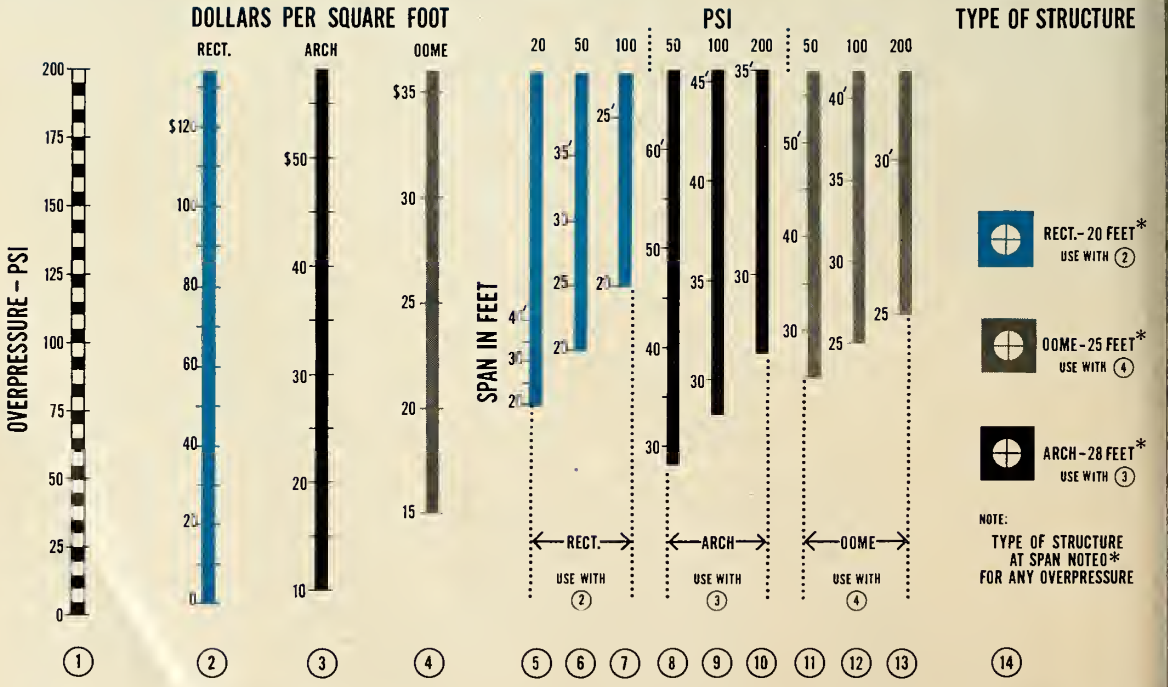
• **A frail reed**—At this moment Civil Defense is an undernourished orphan of government, inept, inadequate, and scorned. Lame ducks and Civil Service time-servers have found a comfortable roosting place in its higher echelons. It adds nothing to our deterrent power. If anything, it is a liability. People believe that in the event of nuclear war they will be protected by Civil Defense. They won't; it can't do the job.

Conversely, the Soviet Union has been quietly concentrating on Civil Defense training for urban populations. Twenty-two hours of training is compulsory for adults in target areas. Public shelters, deep and large, have been constructed *outside* major cities. Obviously, the Russians feel that since we concede them first strike, they will have time to evacuate target cities before retaliation arrives.

In the United States public apathy has been astonishing. This is partly the result of Administration policies designed to play down the horrors of nuclear war, and play up our own strength. One high former Civil Defense official who resigned in frustration and disgust said recently he was handicapped by a White House directive "to say nothing that will alarm the public."

If the public is not alarmed or aroused by the prospect of atomic holocaust, it will not bother to dig in or protect itself in any way. This lethargy has been encouraged by the budetary brushoff given Civil Defense. The annual DOD budget is about $41 billion, augmented by more billions for CIA, the Atomic Energy Commission, Security Service, and arms for our allies. Altogether, preparations for war, or to deter war, cost close to $50 billion annually. The annual budget of Civil Defense has been only about $60 million, or one-eighth of one percent of the total. If one objective of defense is

PRICE OF DEFENSE . . . How to Compute Shelter Cost



ilitary

to save the nation's people, this disparity makes our entire defense effort appear a gigantic boondoggle.

The public attitude of unalarm hides behind many masks. One, despite the most serious warnings of military leaders—and logic—is "Oh, they won't use H-bombs, just like they didn't use gas in the second World War." Another is fatalistic—an "On the Beach" attitude: "If everyone else is going to die, I don't want to survive."

We live on an unstable planet in a time of troubles, although in a world of unlimited hope for progress as well as unlimited danger. RAND, Rockefeller, Holifield Committee, Mershon, and other reports, indicate that 100,000,000 Americans would be killed instantly, or die within 60 days, should we be hit by surprise attack in our present unprepared state. This assumed a Russian first strike of 5,000 megatons delivered by rocket, submarine-based missiles, aircraft, and nuclear mines dropped in our harbors. This weight of death is within the Soviet capability. Even if we "won" such a war by obliterating Russia, we would lose it.

- **Another chance**—Realistic protection of civilians would cut deaths by 50% or more, most authorities agree. We could scramble back on the highway towards civilized progress within five years instead of a century—or never. A strike against this nation today might dump the survivors back into the Middle Ages.

The new Administration is in a position to do something about it.

When he replied to a MISSILES AND ROCKETS open letter, a reply published in the Oct. 10 M/R, Kennedy indicated the course he hoped the Symington Committee would take.

This included joint commands incorporating all three services and built on functional lines; i.e., a Strategic Command, a Mobile Strike Force (Tactical), a Defense Command, and certain area Commands. The Symington proposals closely follow the Kennedy thinking.

Members of the committee recalled the old schoolboy adage that if you are ready to dish it out (which this country is) you must also be ready to take it, which this country manifestly is not. Survival of our 180,000,000 citizens must be fashioned into a strong supporting beam of the national military posture. Obviously, an unprepared population invited attack.

- **The only way?**—So the inclusion of Civil Defense in a military command is under consideration. It would have its headquarters in the Pentagon and its civilian and military chiefs would report directly to top-level officials of the Administration.

Placing Civil Defense within the military establishment is the only logical means of providing it with a stable platform and basic support. In the event of nuclear attack on the United States, martial law would be declared instantly, so in a crisis civilian defense would be subordinated to the military in any case. Furthermore, in all-out war the National Guard and organized Reserve would be called into action within the Zone of the Interior at once. It was felt that the National Guard and the reserve should provide the chief components of the new U.S. Defense Command. It should be their primary mission, the secondary being

(Continued on Page 36)

THIS "DO-IT-YOURSELF" NOMOGRAPH provides a ' to rapidly approximate the costs of various types of ictures at overpressures from 0 to 200 psi. It was de- :d by Burns and Roe, Inc., New York consulting engi- ring firm.

The structures considered are (1) rectangular, above de; (2) arch-mounded or partially buried; and (3) dome, y buried.

The costs from the nomograph are for excavation, icture, lighting and ventilation for a minimum type lity only. For more complex facilities, a first approxi- tion of additional costs for architectural, mechanical and trical items may be obtained from Table 1.

Nuclear physicist Dr. Ralph E. Lapp, consultant to the it Congressional Committee on Atomic Energy, presented overpressure data in Table 2 during recent Congres- ial hearings on civil defense.

The derived costs can be used only as a general guide. riables such as site location, soil type, water table depth, a of structure, and complexity of facility have marked uences.

- **How to use nomograph**—Scale (1) lists overpressures scales (2), (3) and (4) list costs per square foot for angular, arch, and dome structures, respectively. Scale) can be used for any overpressure for the specified span each type of structure. Scales (5) through (13) are used variations in the span and are applicable only for the rpressures noted at the top of the scales.

Example 1: What is the cost per sq. ft. for a 28-ft. span 1 Administrative type facility at 30 psi?

(a) Draw a line from 30 psi on scale (1) to Arch on e (14).

(b) Read $16.7 per sq. ft. on scale (3).

(c) From Table 1 for Arch-Mounded, Administration lding—Additional cost: $11 per sq. ft.

(b) Answer—steps (b) + (c) = $27.70 per sq. ft.

Example 2: What is the cost per sq. ft. for a 35-ft. span 1 minimum facility at 100 psi?

(a) Draw a line from 100 psi on scale (1) to 35-ft. span) psi) on scale (9).

(b) Answer—read $34.80 per sq. ft. on scale (3).

TABLE 1—Additional Costs Per Sq. Ft. For Architectural, Mechanical and Electrical Items

Item	Facility Type	Rectangular, Above Grade ($/sq. ft.)	Arch-Mounded ($/sq. ft.)	Dome, Buried ($/sq. ft.)
ARCHITECTURAL	Admin. bldg.	6	4	6
Partitions, finishes, hung ceilings, etc.	Electronic facility	7	5	7
MECHANICAL	Admin. bldg.	5	5	10
H & V, air conditioning, plumbing, air filtration, etc.	Electronic facility	8	8	16
ELECTRICAL	Admin. bldg.	2	2	4
Lighting, outlets, power connections, etc.	Electronic facility	5	5	10
TOTAL	Admin. bldg.	13	11	20
	Electronic facility	20	18	33

The costs not included: site improvements, entrance structures and blast doors, water supply and sanitary facilities, ventilation shafts, standby power, electronic equipment cooling.

In general, these items increase in cost progressively—from Above Grade, to Mounded, to Buried—and increase with increasing design overpressure. Entrance Structures may represent a substantial percentage of total cost for small or deeply buried structures.

TABLE 2—Blast Overpressures Produced by Explosion of a 10-Megaton Bomb

DISTANCE (miles)	1.0	1.4	1.9	2.8	4.1	6.1	9.7
OVERPRESSURE (psi)	200	100	50	20	10	5	2.5

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Technical Countdown

ELECTRONICS

IR Power Supply Minified

A power supply the size of a flashlight battery developed by Victory Electronics, Inc., for infrared use produces a 16-kv (open circuit), 0.1-microamp output. Even under a load up to 0.5 microamp, voltage change is not more than 800 v, says the company. Both Army and Navy are now testing the unit.

Missile Bloom Effect Measured

Radiation associated with the whitish glow which develops around a missile during nocturnal firings is being measured by Radiation, Inc., at the Missile Test Center, Patrick AFB, Fla. Known as "missile bloom effect," it appears at an altitude of 120 km, has a diameter of several kilometers and persists for many seconds. RI is using its RSVP (radiation spectral-visual photometer) and a 35-mm cine camera for observations which are part of current Interservice Radiation Measuring Program.

EIA Forms Electronics Procurement Committee

Establishment of a new committee to handle Electronics materials management problems has been approved by the Electronics Industry Association. The group, headed by H. A. Strickler of Martin, is composed of procurement and materials directors of EIA member-companies.

Laser Improvement Reduces Power

Raytheon has developed a light-pump reflector which can reduce power required for ruby laser action by about 90%. The new device may aid in development of a sought-after continuous-wave laser.

SUPPORT EQUIPMENT

Azusa Mark II in Use

Convair's improved *Mark II* Azusa missile tracking system has been put into operation at Atlantic Missile range. The $10-million tracking and impact-prediction system also can be used to track space vehicles in orbit and calculate satellite rendezvous and interception points in space.

New Radar Quantizer for Pershing

A new radar quantizer, to be used in 3-D tracking of *Pershing* missiles, is reported capable of providing a position plot resolution of ±2.5 feet. It will be used with a digital computer to provide monitoring engineers with instantaneous position data on the missile test flights. The device is built by Computer Equipment Corp.

Wire and Cable Problems Unresolved

The Department of Commerce hasn't given up the idea, but plans to survey the missile wire and cable situation and help bring some order to the current chaos have been shelved for the present. Big problem is that procurement is handled almost entirely by industry and there is no one body empowered to set specs, requirements, and definitions. (M/R will publish an article in the near future on the prevailing conditions and what needs to be done.)

PROPULSION

Cluster of F-1's Proposed

A two-engine cluster of Rocketdyne F-1's has been proposed by Marshall Space Flight Center. The resulting 3-megapound-thrust booster could be built for use as a flying test bed by 1964—if funds were made available now. Development of F-1—taken over by Marshall last month—is on schedule. Preflight rating tests are planned to begin in late 1962 and be completed by early 1963.

Cracked LOX Dome Plagues Saturn Test

Premature cutoff of the Dec. 2 *Saturn* static test after two seconds was apparently due to a cracked LOX dome. No resulting damage was reported.

Underwater Missile Propulsion Advanced

Compact 20-HP engine developed by Avien, Inc., is believed capable of greatly increasing underwater missile payloads and extending operational depths and operating life. The 17.3-lb. unit offers very low fuel consumption, low rpm, and a minimum number of moving parts, says Avien.

MATERIALS

Madison Ave. Next into Space?

Space writing in orange letters against the evening sky, visible for hundreds of miles, is now a real possibility. According to Lockheed MSVD scientists, the idea is an offshoot of a method of tracking re-entry vehicles by releasing a stream of sodium. The trail would be stable for about 30 minutes; precise measurements would show the exact angle of descent. A similar trail of cesium would be radar-reflective under cloudy conditions, they said.

Steel Casting License Granted

The Parlanti Mould Process of steel casting will be used by the Swedish Crucible Steel Co., Detroit, under license from General Communication Co. The process results in castings with superior mechanical properties through the ability of the moulds to rapidly conduct heat away from the cast mass of metal.

Mo & Nb Alloys Tested for Re-entry

Vehicle re-entry tests will be undertaken at Wright Air Development Division to check out new combinations of molybdenum and columbium alloys. A typical glide re-entry vehicle to be constructed by the Air Force and engineers from General Electric and McDonnell will be put through simulated re-entry.

Toolless Metal Removal Perfected

A new process, developed by Steel Improvement and Forge Co., has no metal-to-metal contact and no tool wear. A part to be machined and electrodes made in the size and shape to be duplicated are placed in a chamber while a rapidly flowing chemical solution carries an electric current from workpiece to electrodes. Rate of metal removal is governed by the amount of electric current applied which varies with the metal type.

Plastic "Starch" to Stiffen Echo

One possible solution to stiffening the next *Echo* balloon satellite (so its reflected signals won't be distorted) is using a soft plastic that can be folded into the satellite but will polymerize into a harder substance by action of strong sunlight.

Russian Glass Reacts to Sunlight

The Russians have developed a glass that turns opaque when exposed to strong sunlight. The milky-white appearance diminishes with solar intensity and the glass becomes transparent again.

INSTANT FLIGHT

Varied stresses of programmed flight will soon be duplicated at ground-level. A $10 million static test facility, designed by Vitro for the U.S. Air Force, will shortly begin operations at Wright-Patterson. Here, major components will be subjected to programmed aero-dynamic heating and dynamic loading of supersonic flight. ■ In eleven major Vitro projects, the precise simulation of unusual environment was vital; twenty-one Vitro projects required design of nuclear containment. This is Vitro know-how.

Vitro

VITRO ENGINEERING COMPANY / A Division of Vitro Corporation of America / NEW YORK • WASHINGTON • LOS ANGELES / OVERSEAS: GENEVA • MILAN • BOMBAY

MPI's 'Hi Mod' Glass Fiber

Material opens new concept of motor cases

by John Judge

THE REMARKABLE PROPERTIES of a new glass fiber material are generating a considerable amount of interest in the missile frame industry.

The material is the result of a process conceived by J. F. Brossy, vice president of Materials and Processes, Inc. B. F. Goodrich is producing the material for its own use under a licensing-consulting agreement entered into with MPI in June, 1959 (M/R, Nov. 28, 1960, p. 28). Negotiations are underway with a British firm for a similar license.

Designated "Hi Mod," the substance actually retains more of the basic strength of the glass fiber and lowers the resin content of the laminate.

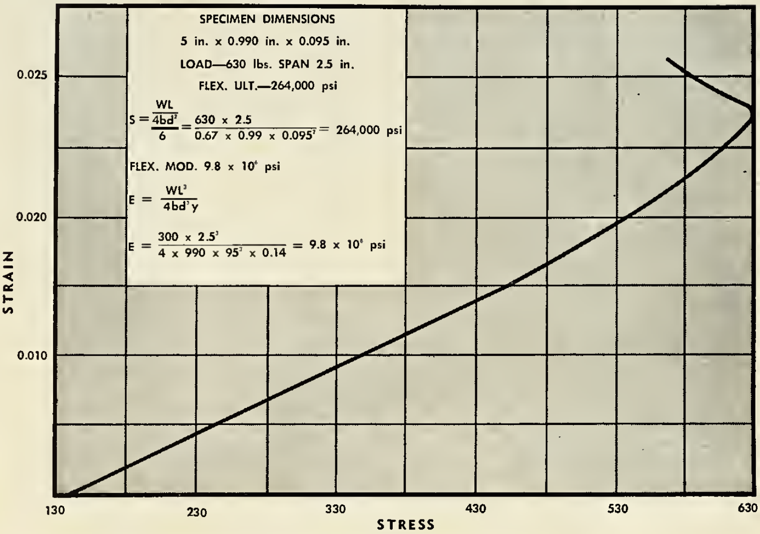
"Hi Mod" is a parallel glass fiber tape drawn from a chemically stable glass and impregnated with a resin microseconds after forming. It was originally developed under a Navy Bureau of Ordnance contract.

• **Wide Resin Range**—The laminate's adaptability permits the design engineer to tailor it to suit his particular purpose. The production method allows the use of almost any resin capable of being B-staged. A variety of resin systems including epoxies, modified epoxies, phenolics, high temperature phenolics, silicones, DAP's and triallyl cyanurates have been successfully applied. Resin content has been as low as 9% and rarely goes over 25% by weight.

According to Brossy, the high modulus of "Hi Mod" assumes greater importance as rocket motor cases increase in size. An entirely new concept in case construction is being explored involving a barrel stave configuration in which the unidirectional Hi Mod fibers can best be used in larger vehicles.

In the complex business of producing laminates, it has long been known that most structural degradation originates at the interface between the resin matrix and the fiber reinforcement. The bond strength is destroyed through capillary action aided by a molecular layer of water on the fiber surface.

• **Weakened fibers**—Another item is that relatively little of the inherent strength of the glass fiber has ever been translated into a glass plastic laminate. Since a fiber of 8 to 10 microns is almost all surface, it is highly notch sensitive. The commercial practice of twisting fibers into yarns, abrading, lubricating, heat cleaning and weaving them removes a major percentage of this inherent strength.



$$S = \frac{\frac{WL}{4bd^2}}{6} = \frac{630 \times 2.5}{0.67 \times 0.99 \times 0.095^2} = 264{,}000 \text{ psi}$$

$$E = \frac{WL^3}{4bd^3y}$$

$$E = \frac{300 \times 2.5^3}{4 \times 990 \times 95^3 \times 0.14} = 9.8 \times 10^6 \text{ psi}$$

HOW "HI MOD" performs under increasing stress and strain.

In addition, the fiber in its nascent state is extraordinarily reactive—readily attracting any substance present in the atmosphere to its surface. This reactivity has given rise to some bizarre effects. In one case it was thought that heavy welding being performed some distance from the fiber extruder was the cause of the otherwise inexplicable presence of iron in the fibers.

It is for this reason that each individual fiber is encapsulated in resin immediately upon leaving the furnace orifice. This matrix resin protects each fiber from abrasion and preserves a major percentage of the available strength.

Brossy feels that it is possible that the polar groups in the resin tend to react with the hydroxyl groupings on the fiber surface before atmospheric elements are attracted.

• **Side by side effects**—This parallel drawing and encapsulation permits true orientation of the fibers as well as a higher glass content. It is generally accepted that glass fibers have little or no elasticity and progressive failure occurs in laminates where some of the reinforcement is kinked or twisted. The parallel orientation reduces this effect. The material can be handled without the usual danger of damage.

Brossy says that a laminate system having a greater number of fibers unharmed by abrasion or contaminates should have superior physical characteristics under load—including moduli.

This is in opposition to the general notion that modulus is not affected by handling or damage to the fiber strength by abrasion.

Successive plies of this oriented mat

Hi Mod Optimum Test Data Uni-directional Flat Laminates

Flexural Ultimate	274,000 psi
Tensile Ultimate	250,000 psi
Flexural Modulus	10.4 million psi
Wet Strength Retention*	96.5%
Specific Gravity	2.1—2.2

*After standard 2-hour boil test

tend to nest together, drastically reducing chances of interlaminary shear.

A greater degree of homogeneity is achieved because of the narrow fiber diameters used instead of threads consisting of 200 fibers or more. Overlapping is minimized and a uniform distribution of resin and reinforcement is attained.

At least one manufacturer has produced a pressure vessel using "Hi Mod" with integrally wound closures having a strength/density ratio in excess of 3 million inch-pounds per pound. This corresponds to a unidirectional stress of 340,000 psi with overall hoop stress above 225,000 psi and accompanying moduli between 9 and 10 million psi. In hydrostatic tests, no moisture vapor barrier or liner material is needed.

- **Honey combed Hi Mod**—The material has also been used successfully for structural reinforcement members. In laboratory experiments, sandwich panels have been fabricated by cross laminating two plies of "Hi Mod" on either side of 1/8 in. cell aluminum honeycomb.

No adhesives were used. The assembly was pressed at 50 psi and cured. Tests to get tension failure in the lower panel were futile—breaks being always in compression. When 4-point loading, span extension and flat plates against the panel were tried, failure occurred —in the core.

Tensile stress on the lower skin was calculated at 285,000 psi. Peel tests resulted in the core tearing.

According to MPI, the characteristics of glass fiber play an important part in the physical properties of the laminate—but only a part. There is a combination of elements that contribute to a successful end product. Such things as the resin and actual winding techniques are also of prime importance.

But the profound effect of stringent quality control measures are such that this control is imperative. In Brossy's opinion, reproducibility can be assured in no other way. MPI is incorporating intensive quality control procedures in their new production equipment.

The firm expects to be shipping Hi Mod in production quantity sometime in April, 1961.

Although MPI is in the position of a materials supplier and not a fabricator, they have a great deal of interest in production. The unusual qualities of their laminates can be nullified through improper fabrication methods. Hi Mod tapes have been used with existing filament winding equipment but it is believed that truly optimum results will require the development of winding techniques better suited to a parallel fiber tape. Such equipment has been designed and is now in use by one of the major motor case fabricators. #

Home Grown Quartz Signals End of Dependence on Imports

Hydrothermal Process at Western Electric produces tailored crystals for communications devices economically

NORTH ANDOVER, MASS.—The U.S. will soon become self-sufficient in one more critical material with the advent of a quartz crystal production facility at Western Electric's Merrimack Valley Works.

Quartz crystals are instrumental in the regulation of radio frequencies and as a source of ultrasonic waves. The material is usually imported from Brazil and certain areas in Madagascar.

The pure, colorless natural crystals required for communications average about $30 a pound in cost. But the presence of imperfections and the waste resulting from the cutting and slicing operations can run the price tag of the final plates up to $1500 per pound!

The growing process was developed at Bell Telephone Laboratories and commercial methods were designed in conjunction with Merrimack engineers.

The hydrothermal process is essentially the dissolving of natural or artificial nutrient quartz crystals in a basic solution and then their redeposition on shaped "seed" plates.

For this purpose, a series of autoclaves were designed and installed at the Merrimack plant. Automatic controls maintain a precise temperature differential between the nutrient (lower) zone and the growing (upper) zone in each autoclave.

Temperatures approaching 700°F and pressures up to 25,000 psi are necessary for the successful formation of crystals. A particularly knotty problem was the design of a repetitive closure for the units.

- **Three-week incubation**—The growing cycle lasts about 21 days, during which time the autoclave is completely under automatic controls. Only three men are required to operate the entire growing area. The vessels are expected to last 10 years before replacement is necessary. For this reason a chromium-molybdenum steel was chosen, as the autoclave material, since the nutrient solution is highly corrosive at the required temperatures and pressures.

The synthetic crystals have a number of advantages over their natural brothers. Besides offering the obvious merits of availability and size, the material can be grown in configurations that permit the most efficient sawing and shaping operations.

The grown crystals have none of the impurities often found in even the best natural stock and can be produced without either optical or electrical twinning.

End product yield of the artificial quartz is estimated to be about 2.5 times that of the natural crystals. Western Electric officials indicate that the growing facility will ultimately provide 90% of the Bell System's crystal needs. The nutrient crystals used as the starting product or small, inexpensive pieces of natural quartz, readily available from many sources but totally unsuitable for communications purposes.

Some research has been performed on other starting materials, such as certain types of sand. But Western Electric feels there is no real need for alternative raw materials since the current one is in abundant supply.

The process is being licensed by some firms both here and abroad. The development will prevent the occurrence of a critical shortage of quartz during national emergencies. In addition, the reduced cost of the artificial crystals may prompt their use in wider applications as substitutes for other elements in electronic circuits. #

SYNTHETIC QUARTZ CRYSTAL emerge from an autoclave three week after the seed crystals were sealed withi the vessel.

Evaluator May Be Used for Saturn

Packard Bell's SE-1000 is relatively simple, highly reliable and easily adapted to new requirements

THE NEXT MAJOR SERIES of static tests of the *Saturn* may use Packard Bell Electronics' new SE-1000 Systems Evaluator. Contract negotiations for the computer-controlled automatic checkout system are now being conducted at the Marshall Space Flight Center.

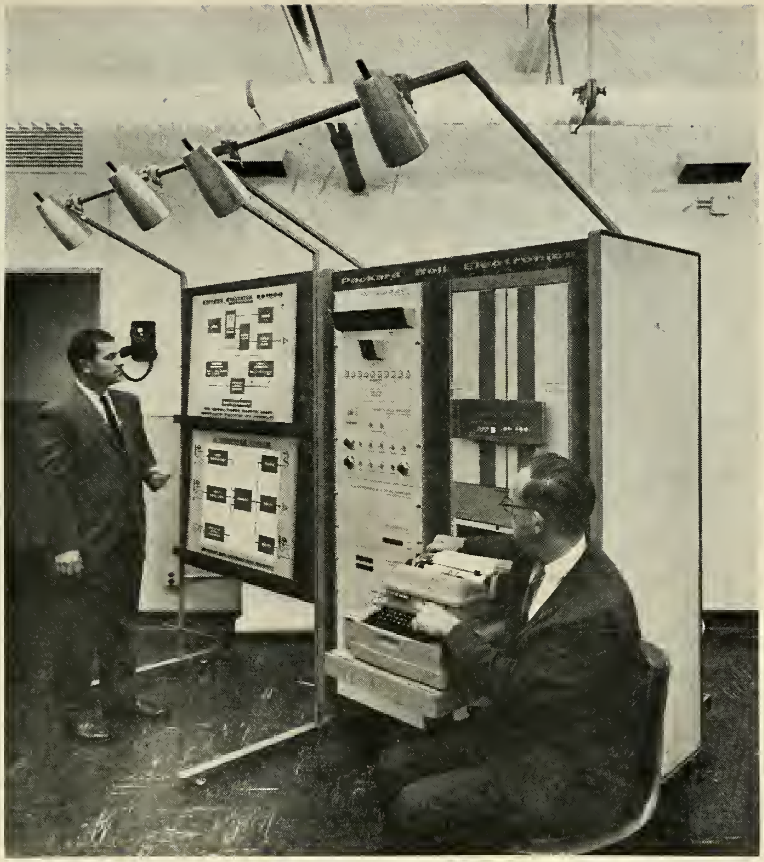
Packard Bell claims that the SE-1000 is less complex and more reliable than an equivalent programer-comparator.

It is sufficiently flexible, the company reports, to handle any number of different missile systems, ranging from large multiple-engine liquid boosters to small solid-propellant units.

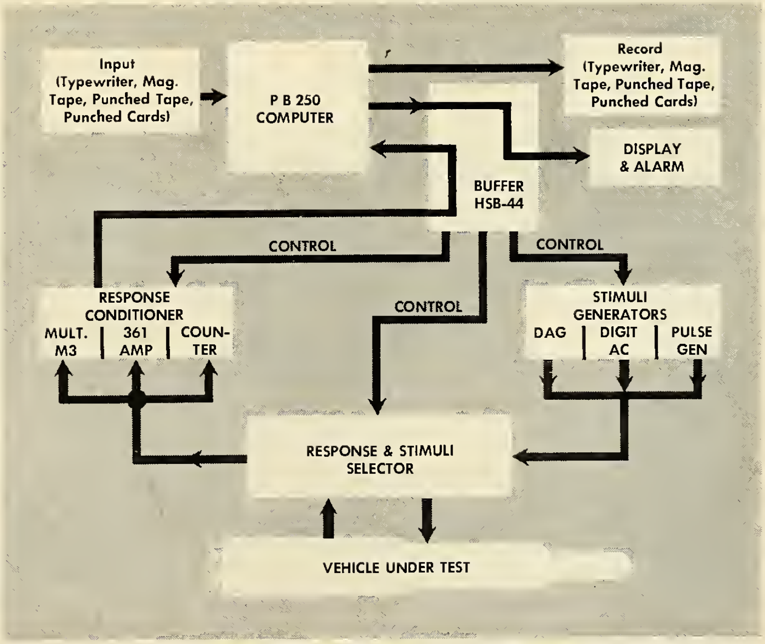
The system was demonstrated last week at the American Rocket Society meeting in Washington. Among the observers were Navy engineers who could be considering the SE-1000 for use with *Polaris*. Packard Bell built factory checkout equipment for *Polaris* and used many of its developments in SE-1000.

The system has several advantages. Probably its best feature is that it is made up of off-the-shelf components, including the pb250 computer, the heart of the system. This solid-state general-purpose computer has been available for some time as a commercial unit.

Another big advantage is the versatility, or flexibility, of the system. Packard Bell claims that computer control allows changes to meet the requirement of different systems, new instrumentation, or changed programs with little or no change in hardware design. It can incorporate manual control inputs in parallel with computer control with no modification. A further claim is that the SE-1000 is easily adaptable to factory, depot, or line checkout requirements as well as to component, subsystem, and total system level.



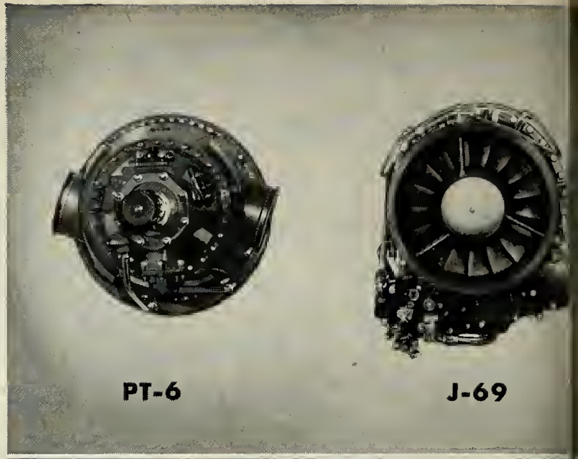
SE-1000 PROTOTYPE is used in demonstration of system performance. A "space vehicle simulator" in the console serves as the unit under test.

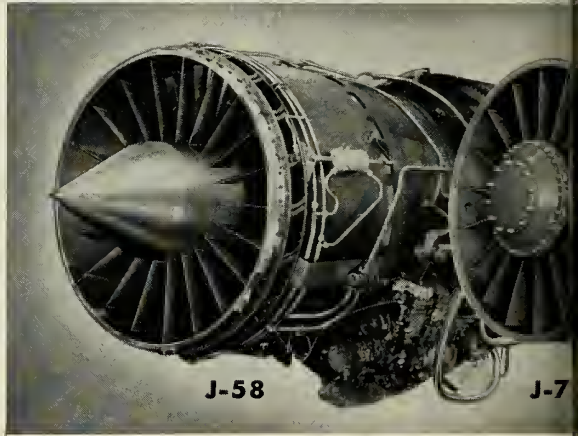


EVALUATOR USES a general-purpose computer in place of more conventional programer-comparator units. Other system components are basically the same.

Controls for the "hot ones"

- for over 23,000 aircraft gas turbines
- for a liquid hydrogen rocket engine
- for the B-70's air-induction system
- for the power forms of tomorrow

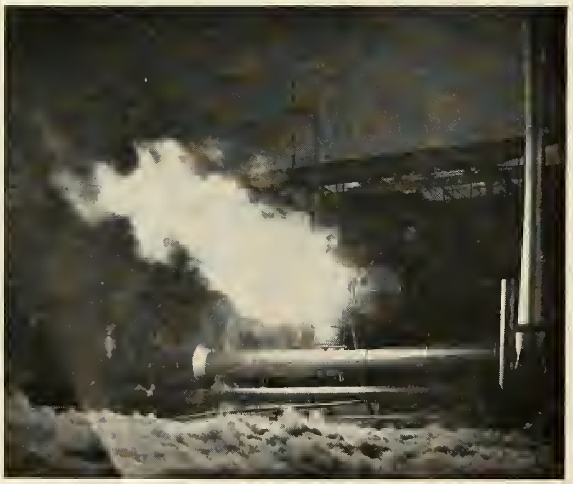




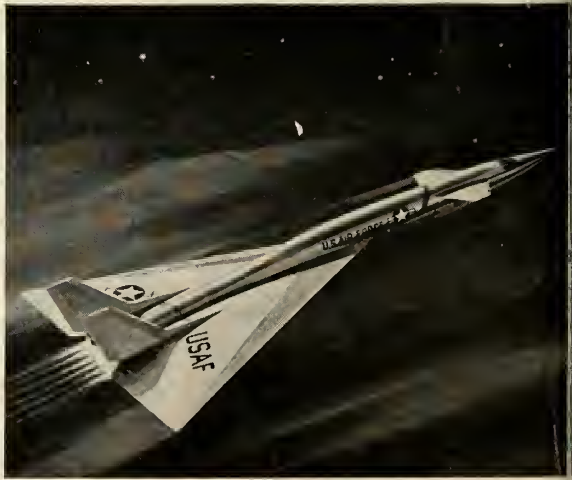
Hamilton Standard has supplied fuel and engine controls for over 23,000 aircraft gas turbines—powering 17 types of the nation's leading military and commercial aircraft.

Today, its experience is being applied to a new generation of "HOT ONES" . . . controls for an advanced liquid hydrogen rocket engine . . . a unique air-induction system for the USAF B-70 . . . hot gas servos and other hydraulic, pneumatic and mechanical devices for missiles and space vehicles. And for the power forms of tomorrow, Hamilton Standard research is furnishing new ideas for control of ion engines, fuel cells, ramjets and industrial gas turbines.

Hamilton Standard has the ability to solve your control problems—from concept to completion. Your inquiry is invited.

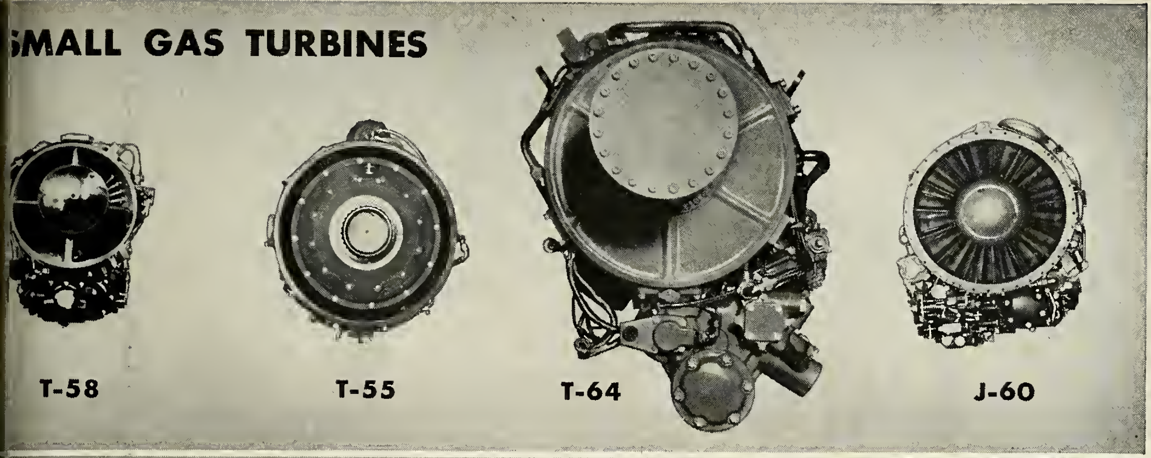


ROCKET ENGINE CONTROLS. Hamilton Standard has developed thrust modulation controls and fuel-oxidizer shut-off valves for an advanced liquid hydrogen engine. This work has provided important breakthroughs in low-temperature sealing problems and system reliability.

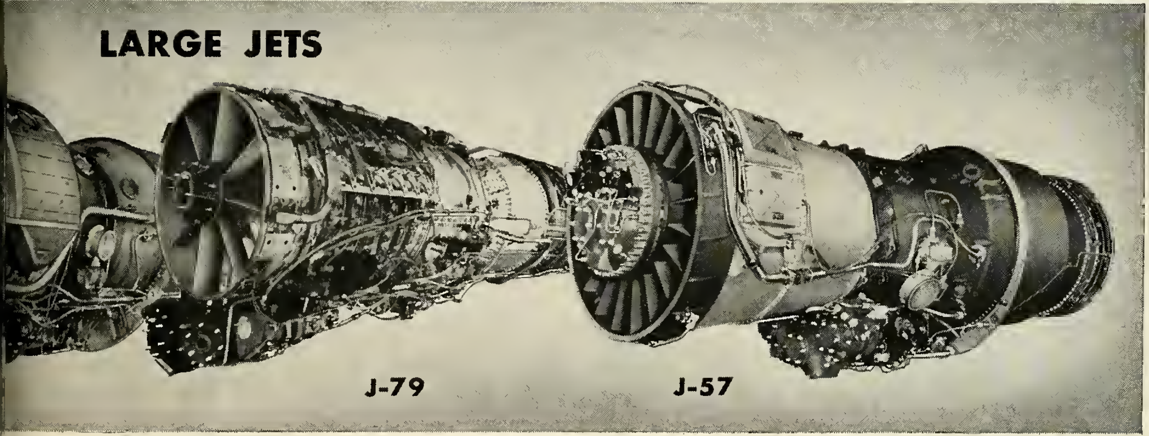


B-70'S AIR-INDUCTION CONTROL SYSTEM, now under development at Hamilton Standard, involves some of the most advanced control problems ever encountered. It is designed to provide the most efficient air-flow into the plane's engines over an unusual range of operating conditions.

SMALL GAS TURBINES



LARGE JETS



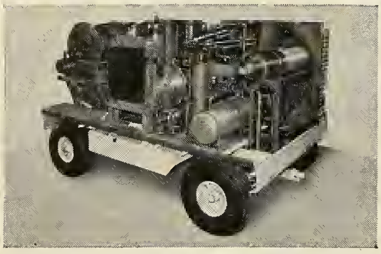
HAMILTON STANDARD

DIVISION OF UNITED AIRCRAFT CORPORATION

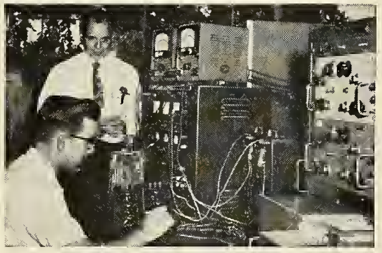
WINDSOR LOCKS, CONNECTICUT

SOME OF THE MANY FIELDS OF GROWTH AT HAMILTON STANDARD

ENVIRONMENTAL CONDITIONING SYSTEMS for space vehicles and such advanced aircraft as the B-58, 880, B-70 are important aspects of Hamilton Standard diversification.



GROUND SUPPORT EQUIPMENT. Hamilton Standard is presently producing a wide range of GSE for both missiles and aircraft—from special tools to complete systems.



ELECTRONICS at Hamilton Standard includes broad experience in flight control, instrumentation, static power inversion and electrical control for aircraft, missile and GSE components.

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Making Dyna-Soar 'Safe' for Its Pilot

A report on the Air Force's unprecedented effort to give maximum protection to its space travelers; why 'safety' and 'reliability' aren't always synonymous

by Everett J. Hodapp, Jr.

Mr. Hodapp is Dyna-Soar Engineering Officer, Wright Air Development Division, Wright-Patterson AFB, Ohio. This article is reprinted from the December, 1960, issue of AEROSPACE SAFETY, published by the Office of the Deputy Inspector General for Safety, USAF, Norton AFB, Calif.

WITH THE DAWNING of a new age in aviation history—manned space exploration—it is essential that an active, vigorous safety program be established for each of the many space research projects scheduled or contemplated. The hazards involved in boosting a vehicle into space, orbital flight and re-entry make it necessary to redirect the safety efforts applied to conventional aircraft.

Of immediate concern to the Wright Air Development Division is the development of the *Dyna-Soar* Military Test System. This consists of a piloted hypersonic boost-glide vehicle, a booster to place the glider in flight, the ground launch complex, the ground support systems, and the ground tracking and communications facilities.

The overall objectives of the program are to demonstrate piloted boost-glide flight up to orbital speed with hypersonic re-entry into the atmosphere and maneuvering to land at a preselected conventional air base, and to lay the groundwork for the military systems which will exploit these technical advances. This is to be accomplished by a flight test program at two sites. It will encompass two distinct phases.

First, the full-scale piloted glider will be tested at Edwards AFB, Calif., by a series of drop tests from a specially modified B-52 aircraft. Performance will be limited in these tests. However, the glider handling characteristics will be evaluated as well as basic subsystems performance.

This test phase will be followed by a series of ground-launched unmanned and manned flights from Cape Canaveral on the Atlantic Missile Range. These tests will show how the glider responds in the hypersonic flight regime to the maximum-velocity capability of the booster.

After these sub-orbital flights are successfully completed, the same glider thus far developed in the program will be boosted from Cape Canaveral to velocities which will enable it to circle the earth and land at Edwards AFB.

It is readily apparent that the *Dyna-Soar* safety program must cover many aspects. At this stage of the program, primary emphasis is being placed on formulating a system design which minimizes the possibility of fire, explosion, release of toxic vapors, and inadvertent or abnormal component actuation. Such hazard-preventing activities are applied to all manned vehicles. But, a greater emphasis has been placed on the manned space vehicles for these reasons:

- Pilot survival has been stressed and programs to insure man's safe return have been given high priority in both the NASA Project *Mercury* and the *Dyna-Soar* Program. Escape from orbital vehicles has not been perfected to the point of assurance of successful escape from the primary vehicle. For this reason the primary vehicle must be designed for maximum operational safety—which may necessitate compromises in performance.
- A catastrophic failure at any point in the mission profile could cause the pilot to escape and land in a remote land area or at sea. How to search for and recover him is a serious problem. An active program during the development period to design and install highly efficient and reliable subsystems will markedly reduce the likelihood that escape action will be necessary.
- To develop the required system in the time allotted, it has been necessary to anticipate state-of-the-art advances within this time and utilize such breakthroughs in many design areas. This is justifiable in light of the existing competition between world powers, but such a procedure limits the amount of testing which can be conducted prior to integration into the production article. For this reason, design safety analyses are an important part of the development cycle. Modification to improve overall safety and reliability must be made early.
- There are many "grey" areas in trying to anticipate the exact conditions which the space vehicle will encounter in orbital flight. A part of any effective safety program is to analyze the expected hazards through a careful review of existing data obtained from exploratory NASA and military programs such as the *X-15* and *Discoverer*. From this information, certain potential hazards can be appraised and appropriate safety precautions taken.

To present a detailed account of the *Dyna-Soar* Safety Program at this time is not possible; the program is new and there are design changes every day. A fundamental operational concept, however, has been formulated by the Fire Protection and Safety Section of the *Dyna-Soar* Engineering Office—as have the requirements for basic protection devices.

The primary objective is, of course, to provide a military test system capable of exploring the hypersonic and orbital flight regime which will assure the ultimate in pilot safety. A continuous coordination effort is being accomplished within the *Dyna-Soar* System Project Office to insure that final design approaches give adequate consideration to safety implications.

The same approach is being followed by the Boeing Airplane Company, prime contractor on the *Dyna-Soar* program, its subcontractors and the USAF associate contractors. The mechanics of the safety programs involve safety and reliability groups at management level. Boeing has established a Fire Protection and Safety Office to maintain surveillance of fire and safety aspects of the overall *Dyna-Soar* System. This function is complemented by individual safety engineers at a design level for each major element of the system. These elements include glider, booster, launch complex, and support equipment. In many cases the reliability and safety efforts of subcontractors have been placed in one common group.

While reliability and safety are closely related, there are unique differences in how they are dealt with in the early stages of system development. In the selection of the best subsystem design approach, safety is influenced by the mode of operation, materials utilized, and packaging concepts.

As an example, consider the selection of an electrical power system for a short-flight-time glide vehicle. A battery could be designed to accomplish the desired function. Another alternative would be the use of a chemically fueled power-generating device. Through design efforts and use of redundancy the two approaches could be given similar operational reliabilities.

From a pure safety viewpoint, however, the battery is free of the hazard potentials of fire and high-speed rotating equipment. Relative system weights may make it prohibitive to use batteries, but it is obvious that they offer certain safety benefits.

Although operational reliability and safety are similar in nature, using the terms synonymously may lead to an oversight in the space system development phase which could create problems when the system becomes operational. This is especially true when there is a market variance in the degree and nature of ground support for the subsystem approaches. Servicing a subsystem with hypergolic fuels and oxidizers present many safety problems not encountered in servicing with conventional fuels and ozidizers such as RP-1 and LOX.

Safety information published and operating procedures established by the Ballistic Missile Division contractors on the ballistic missile programs, and the basic research conducted by the Directorate of Advanced System Technology at WADD, complement safety approaches enforced during development of aircraft systems. Programs analyzing the hazards associated with the use of hydrogen have been completed, work is now being conducted to evaluate methods of surpressing fires involving propellants proposed for our space research programs. The safety procedures enforced in such programs as *Titan* have been very effective. Such procedures can to a large extent be applied to the launch site safety efforts necessary for the *Dyna-Soar* ground-launched flights.

These design safety approaches for the *Dyna-Soar* glider have not as yet been finalized, but the following programs are being developed to improve overall system safety:

- A materials selection program will analyze all materials scheduled for incorporation into the glider. The analysis will consist of determining the thermal decomposition characteristics of each material used and determining the relative safety from the viewpoint both of toxicity and of fire. Where materials show an unacceptable hazard potential, the program will look for a suitable replacement. NASA has pursued a similar program for the crew station on Project *Mercury*; it has changed, for reasons of crew safety, several materials proposed by the prime contractor.

BIG FLIGHT for Dyna-Soar will follow series of sub-orbital tests. Boost-glider will be piloted around globe from Cape Canaveral to Edwards AFB.

- In several areas of the *Dyna-Soar* glider there is a potential fire hazard, should propellant leakage occur during critical flight conditions when ignition may occur. Every effort is being made to incorporate passive safety measures to minimize such a possibility, but a means must be found to enable the pilot to visually inspect remote regions. It has been demonstrated that the temperature sensitive and surveillance detectors now available are not highly reliable.

Many difficulties of moisture, wiring and maintenance have been encountered in the detection system. It is unlikely that the pilot would have enough confidence in the system to initiate glider escape solely on the basis of a fire or overheat warning light.

A lightweight surveillance system utilizing optical fibers has recently been introduced to the fire detection system industry. It is composed of a fiber boundle consisting of glass fibers 0.002 in. in diameter. Each fiber can transmit light from the desired surveillance point to a viewing station.

If several thousand units are placed in a bundle, a picture can be transmitted from the hazard area of *Dyna-Soar* to the pilot's compartment. Where only the detection of flame is required, the system requires a simple type of fiber bundle construction. To obtain a picture quality image requires a bundle of more fibers which are oriented. Much remains to be learned about fiber bundle performance in different environments; but it is acknowledged that using such a system will make it possible for the pilot to visually appraise the hazard before he initiates corrective action.

When the fiber bundle is utilized with a conventional temperature or surveillance detector, the pilot will respond to the temperature indication by visually viewing the area of concern. The *Dyna-Soar* Engineering Office is also considering use of this lightweight surveillance system for checking the possible presence of fire, smoke, fluid leaks, or other hazards within remote parts of the system such as the booster and transition section.

In regions of the glider where a high probability of fire or explosion remains after all practical hazard prevention techniques have been incorporated, the use of explosion suppression systems is being considered. In general, these systems consist of a pressure or light sensitive detector which picks up the small pressure rises or light emission associated with the initiation of an explosion.

In milliseconds, the detector responds and automatically discharges chemical suppressants. The action inhibits the explosive reaction—and, in hydrocarbon and air explosions, prevents pressure rises from exceeding approximately 3 psi. This technique eliminates structural and component damage, whereas an uninhibited explosion, which could produce pressure rises in excess of 100 psi, would have caused a catastrophic failure. As the *Dyna-Soar* glider design is finalized, a parallel program is planned to evaluate the effectiveness of explosion suppression systems on the fuel-oxidizer and monopropellant reactions which can be anticipated. When analyses so indicate, suppression systems will be integrated into the design.

(Continued on page 42)

Will Soviets Orbit First Ion Engine?

Details of Russian rocket engine experiment leads U.S. experts to predict another Red victory unless we press our effort

by Frank G. McGuire

PASADENA, CALIF.—Russia may put an operating ion engine in space before the United States does, according to experts who have studied progress in the field.

High-quality work in ion propulsion has been described in a technical publication which spells out the characteristics of the Russian engine, the instrumentation used and the scientific approach followed.

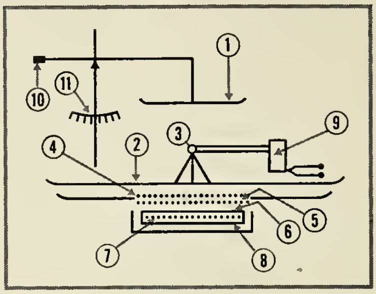
Dr. A. Theodore Forrester, head of the Ion Propulsion Laboratory at Electro-Optical Systems, Inc., evaluated the Soviet technical report of September, 1958, *An Experiment in Producing Reaction Thrust in a Laboratory Model of an Ion Engine.* He told M/R that the USSR appears to have been "at least on a par with American work of the same period, and ahead of ours in certain respects."

Continued Russian interest is evidenced by recent translation of a paper authored by Dr. Forrester and EOS scientist Dr. Robert Speiser which appeared in the Soviet publication *Astronautics and Rocket Dynamics.*

"Assuming that their effort since 1958 has been comparable to ours, and there is no reason to assume that it has not been, they are at least as close as we to placing an engine into space. I would say they are likely to do it sooner," he predicted, "based on the greater payload capability of their boosters, which would allow for more equipment, such as power supplies and instrumentation, in the vehicle."

• **U.S. has the horses**—If the U.S. put forth the effort, Dr. Forrester declared, it could put an ion engine into space first, because we do have reliable boosters for the task. EOS is developing a demonstration ion engine for the Air Force, and its space applications are rather obvious—although EOS will go no further than to state that the engine is being developed.

At the time of the Russian report, the Soviets were generating higher currents and more thrust than any United States laboratory at the time, and also had better instrumentation.



Soviet Experimental Ion Rocket Engine: Circa September 1958

1. **Deflection plate for thrust measurement**
2. **Screen grid**
3. **Feed opening for cesium vapor**
4. **Grid for emitting electrons**
5. **Cutoff Grid**
6. **Surface for emitting ions**
7. **Emitter's Heater**
8. **Thermal Shields**
9. **Cesium Evaporator**
10. **Counterweight**
11. **Scale for reading thrust level**

"The Russians were measuring thrust levels before we were," Dr. Forrester said.

• **Knowingly naive**—Not all of the Soviet picture is rosy, however. A "dead-end approach" was used, according to Dr. Forrester, in the Russian engine's feed system. In a practical system, he said, it is necessary to use a fine, porous-tungsten ionizer, with cesium being fed from the upstream side. Instead, the Russians sprayed cesium from above onto a hot tungsten plate and collected the resulting ions, accelerating them with electrodes. The thrust obtained by this method was about one millipound.

"Their approach was naive in many ways," Dr. Forrester pointed out, but they knew it. There was just too much natural cesium in the ion beam and the accelerating grid structure would very quickly wear away from ion bombardment."

Approaches paralleling the Soviets' have been followed in this country, Dr. Forrester said, but the approach most likely to lead to successful flight-type ion engines calls for using a porous tungsten ionizer, feeding cesium from the upstream side, and very carefully controlling ion focus to prevent ion bombardment and erosion of the electrodes.

• **Soviet engine details** — Surface ionization in the Russian experimental engine took place on a tungsten plate having an area of 70 cm^2 and heated to about 900°C by a tungsten emitter. The emitter's potential in respect to the ground was +3 kv.

The grids were placed 10 to 15 millimeters apart above the emitter's surface. An outside grid was used for emission of electrons, compensating the ion flux. The grid was of tantalum wire 0.2 mm in diameter, heated to 1700°C, with zero potential.

An additional grid with a potential of –0.5 kv was used to prevent reverse current flow. This grid was made of tungsten wire 0.3 mm in diameter, heated by electric current to a temperature which excluded the adhesion of cesium, therefore providing for a minimum emission of electrons from the grid.

Metallic cesium was evaporated in a special heater at 200°C. The atomic cesium beam was then let out through an opening in the feed tube and fed onto the emitting surface.

Temperature of individual elements in the system was controlled by thermocouples, an optical pyrometer and electric wire resistors. The selected resistances corresponded to the exhaust velocities of cesium ions, amounting to 70 km/sec.

A mobile system incorporating a nickel plate and located in the path of the beam at 10 centimeters from the engine was used to measure thrust. The force acting on the plate was measured on the basis of the plate's deflection from the equilibrium position. Both the mobile system and the cesium feed system were shielded against the dissipated fields by a nickel shield and by a grid.

The engine was placed in a vacuum chamber equipped with electrical leads and inspection windows. Pressure relief of about 10^{-5} mm of mercury was maintained in the vacuum chamber. During the loading of the metallic cesium, the installation could be placed inside a protective argon envelope.

The deflection of the plate in the thrust measuring system was observed during accelerated voltage feed to the emitter under a heated condition of the cesium evaporator. The ion current had a magnitude of 70 milliamps in the emitter circuit.

Measured thrust was 0.5 ±0.1 g. Under these conditions, the Soviets said, the rated thrust value was 0.66 g.

There was considerable parasitic losses of neutral cesium atoms in the engine system, the experimenters reported, because a part of the atomic cesium beam bypassed the emitter surface. "These losses can be decreased," they said, "by using other systems of feeding the cesium atoms to the emitter surface, such as feeding through a porous emitter, mobile emitters with divided cesium adhesion zones and ion emissions, etc."

The paper indicates that the researchers were aware of the other criticisms of their system and planned to correct its faults.

• **Remaining problems** — Most of the problems which faced the Soviet workers in 1958 also faced other research teams, but most of these have been licked. EOS, for example, feels that it has enough experience to design a flyable ion engine right now.

The company is attacking the problems that remain. It is studying ways of preventing the scattering of cesium ions by neutral cesium vapor, choosing materials which will stand up under ion bombardment and decreasing the beam interception.

A space test of the ion engine design is necessary because of the significant difference between the walls of a vacuum chamber in a ground test and the infinite boundary of the space environment.

Dr. Forrester strongly advocates carrying out such a test as soon as possible—"even if it is on a scale too small for use of the engine as a prime propulsion unit."

Eventually, fully developed ion engines will have a major impact on space missions. Dr. Forrester pointed out that "adaptations of this type of propulsion for long-range trips to Venus and Mars and for hauling heavy payloads are but two of the obvious uses."

"A wide variety of applications also exist for near-space vehicles involving orientation, homing, guidance, control and vectoring controls for periods of time on the order of years. These factors make ion propulsion a field demanding intensive endeavor," he declared. "With these applications foremost in mind, every possible effort should be exerted to be first in space with ion engines." ⌘

Rocket Fuels Surpass Alloy State-of-Art; Research Program Underway

Recognizing that the new higher energy solid propellants required by the nation's missile and space programs cannot be used without definite advances in present motor materials, Grand Central Rocket Co. is placing substantial emphasis on a materials research effort. This effort is a significant portion of a $1,750,000 company-sponsored research program and it will explore fabrication techniques as well as new materials.

It is anticipated that in the period through 1970, motor cases will have to withstand substantial internal pressures and high temperatures within ever lower weight allowances and with increasing reliability. Thrust vectoring systems and nozzles also will operate under more extreme environmental conditions with flame temperatures as high as 7300°F and greater tendencies toward erosion. Promising materials for this type of operation appear to be an alloy of high melting point metal carbides, which can withstand temperatures of more than 7000°F.

Another most important area for investigation is that of design and fabrication techniques which will allow the use of very large, multi-million pound-second solid boosters as well as long duration high mass ratio solid motors for space applications. As the available energy of solid propellants becomes greater, the design and fabrication problems of such motors become critical with lightweight joints and minimum insulation assuming great importance relative to effective overall motor performance.

Appreciation of these and corollary inert parts problems has led Grand Central Rocket Co. to include materials and fabrication techniques in its broad program of rocket motor research aimed at development of the highest performance, greatest reliability and lowest cost rocket propulsion systems attainable.

Positions open for chemists, engineers
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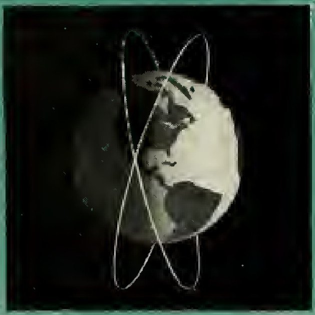

LUNAR PROBE

The moon — lacking an erosive atmosphere — may hold the key to the history of the solar system. Because of this lack of atmosphere, oceans, and wind, lunar explorations may help solve fundamental, universal questions.

Logically, the moon will be the first objective in the exploration of space. Initially the moon itself will be photographed and instrumented; then manned observation stations will be established for astronomical and meteorological purposes. In time, the moon will serve as an intermediate station enroute to other planets — step by step into infinite space.

The National Aeronautics and Space Administration's Lunar Program will utilize Lockheed's AGENA B satellite to play a significant part in forthcoming lunar explorations — as well as a host of other scientific space missions. The NASA lunar launch in 1961-62 will utilize the highly reliable Lockheed AGENA as second stage to carry the RANGER spacecraft. The AGENA will provide the extremely critical guidance and controls necessary to place the RANGER on the required lunar impact trajectory.

The lunar probe application demonstrates the versatility, reliability and success of the AGENA vehicle in Lockheed's satellite and spacecraft programs. Developed for the Air Force for use in the DISCOVERER program, the AGENA is utilized in the MIDAS missile defense alarm system and the SAMOS surveillance satellite system. Noted for a record of outstanding accomplishments, the AGENA is credited with being the first to be placed on a polar orbit; first to achieve a precise, predicted and nearly circular orbit; first to attain attitude control on orbit; first to eject a reentry capsule which was successfully recovered. The AGENA can be modified for a variety of space missions such as navigation, geophysical investigations, long-range communications and deep space probes.

Lockheed's capability in satellites and spacecraft, manifested by such an achievement as the AGENA, encompasses the entire field. It includes current and long-range programs such as interplanetary probes, global and space communication systems, and manned space travel.

Engineers and Scientists: The accomplishment of such programs offers challenging opportunities to engineers and scientists in the research, design, development, test and operation phases of these programs. If you are experienced in work related to any of the above areas, you are invited to write: Research and Development Staff, Dept. L-29, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed / **MISSILES AND SPACE DIVISION**

Systems Manager for the Navy POLARIS FBM; the Air Force AGENA Satellite in the DISCOVERER, MIDAS and SAMOS Programs

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Filter 'Super Cleans' Polaris Fluids

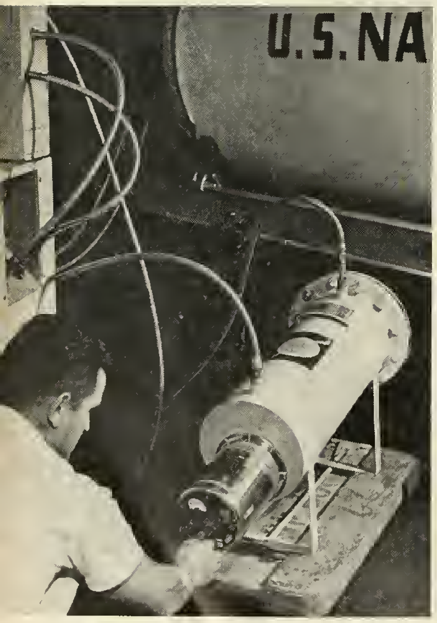
Lockheed reports highly satisfactory results in ground tests of radically different decontaminating method

Los Angeles—An electronic filter that makes fluids "super clean" has been developed by Permanent Filter Corp. and is being widely used in the *Polaris* program. Lockheed Missiles and Space Division has been evaluating the filter, designated Perma-Ray, for more than a year and is highly pleased with it.

Robert Lubben, manager of the Perma-Ray Division, said the filter has been in field test for several years, and differs so radically from conventional filtering techniques that there are no military specifications written for it.

The 260-lb filter operates on basic electrostatic principles applying a negative charge to particles in a fluid, which are then attracted to a positively-charged grid and held in the filter. Tests of the unit have produced impressive results of its capability to clean systems of all contaminants.

Two models now being marketed are designed for MIL-5606 and OS45, and other hydraulic and engine fluids of like resistance. (MIL-5606 is the hydraulic fluid used in the *Polaris* and *Minuteman* systems for flight control.) Use with other fluids would require some modification of the power source.



EXCLUSIVE M/R photo shows Perma-Ray filter in use on Polaris ground test.

In the *Polaris* tests, four barrels of contaminated MIL-H-5606 were connected to a ground test unit at LMSD, making a reservoir of about 305 gallons. At a constant temperature of about 140°F and a flow rate of three gallons per minute at 3500 psi, tests were conducted over five eight-hour periods. No filters other than the Perma-Ray were in the system.

S. W. Brewer, LMSD research specialist in reliability and parts application, said the results were extremely favorable. The metal count in the fluid, in the 5 to 15 micron range, dropped from 69,100 particles to 5100 in eight hours. Plastic count, in the same size range, dropped from 21,325 to 3400 particles in eight hours. The gelatin count, also in the same range, dropped from 4550 to 4160 particles in eight hours, and to 105 particles at the end of the 40-hour run.

Particles in the 15 to 50 micron range showed similar drops, and particles over 50 microns were completely removed.

- **Time saver**—In other tests, Permanent Filter said, the unit has reduced the contamination level from an uncountable millipore reading to 690 particles in the 5 to 15 micron range in only five passes.

Brewer said the *Polaris* system once took approximately six hours to completely purge for meeting flight specifications. This is now done much better in 1½ hours with the Perma-Ray unit, he said. Down time thus has been reduced by two-thirds.

Specific advantages over a mechanical filtering system were spelled out by LMSD, which cited the 24-hour period required to clean ten gallons of MIL-H-5606, versus the 1½ hour average time of the new device for the same amount. Other improvements were in down time from filter changes, low flow rate of mechanical filter systems, and element breakdown which re-contaminates the system.

"We installed the Perma-Ray units in July here," Brewer said, "and since then we have never had any down time on them, have never had to change an element, and they've given us cleaner hydraulic systems than we've ever had."

- **Safeguard**—An interlock is available to immediately turn off a system pump, in event of power failure at the filter unit. This prevents contaminants from being forced through the inoperative filter by an active pump.

"We've learned that you can't ever get a system 100 percent clean," Brewer commented, "because simply turning on a hydraulic pump may increase the contaminant content in any system up to 400 percent, due to metal being shaved, or other foreign matter being sloughed off the internal parts of the system."

LMSD has purchased over 15 of the Perma-Ray filters to date, and has recommended that the Navy install them on fleet ballistic missile submarines and subtenders to provide the filtering required.

"This is a sophisticated unit," Lubben pointed out, "and shouldn't be used where regular filtration systems can satisfactorily perform. We think it should only be applied where extreme levels of decontamination are needed."

In its grid design, the Perma-Ray operates through a concept of precharging the particles and routes the fluid on a twisting course through the device, so the fluid is in intimate contact with the filter element and has maximum exposure to the electrostatic field.

In addition to the grid system, a special porous media is used to reduce the velocity of individual particles in the fluid. Intermittently, grids establish a number of fields of flux, alternately negative and positive throughout the length of the porous media and the filter element.

The field within the element is established by a power supply with a 15,000 volt, five milliampere DC output, having a 110 or 220 volt AC input. Variations in this setup would be made with changes in the fluid to be handled by the filter.

An on-stream, multi-pass system, the Perma-Ray has no absolute micron rating, but the company says it will remove more contaminant from MIL-H-5606, particularly sub-micronic particles, than any mechanical filter can. This in addition to great holding capacity, minimum pressure drop and extremely low maintenance.

Some 97.6% removal of all particles is achieved within ten passes, Lubben estimated, emphasizing that the Perma-Ray is not an absolute filter. ⁂

All-solid Craft Urged for Moon Trip

A PROPOSAL FOR an all-solid space vehicle to land a man on the moon by 1967 was one of the technical highlights of the ARS meeting in Washington. Total cost of the lunar vehicle was put at $2.3 billion.

Two Grand Central Rocket Co. engineers, H. L. Thackwell and R. M. Pierce, presented the all-solid plan which, they said, would provide for R&D and flight of 100 five-stage vehicles, each capable of orbiting 250,000 lbs. of payload. Their development plan calls for 60 R&D engine tests and 15 flight tests before the vehicle would become operational for lunar landings by 1967.

Thackwell's paper outlined a series of three all-solid vehicles based on a Tinkertoy-like series of buildups from a basic propulsion module. The final stage of each vehicle would be a single segment weighing 119,000 lbs. and generating a thrust of about 225,000 lbs. for 70 seconds. A circular head would be attached to each end to accommodate a cap on one end and a nozzle on the other. This basic single-cylinder unit was designated Design I.

The rest of the vehicle would be made up of motors similar to Design I but with a larger nozzle and consisting of five thrust segments. This Design II motor would weigh 464,000 lbs. and generate a thrust of 1,128,000 lbs. A single Design II engine would be the next-to-last stage of each vehicle in the series.

The authors proposed three space boosters built with these basic modules:

–Type A –A 3-stage vehicle boosted by four Design II motors with a stage weight of 1,856,000 lbs. and takeoff thrust of 5,640,000 lbs. Would be available for routine flights in four years and have an orbital lift capacity of 30,000 lbs. Total cost of R&D and flight of 100 production models would be $612 million, or $204 per lb. of payload in orbit.

–Type B –A 4-stage vehicle made up of a type A on top of an 8-engine cluster of Design II engines. Stage weight would be 3,712,000 lbs. and takeoff thrust 11,250,000 lbs. Available for routine flights in 4½ years and have an orbital lift capacity of 100,000 lbs. Total cost of R&D and flight of 100 vehicles would be $1,171 million, or $117 per lb. of payload in orbit.

–Type C –A 5-stage vehicle consisting of a type B boosted by a cluster of 16 Design II motors. Stage weight would be 7,424,000 lbs. and takeoff thrust 22.5 megapounds. Total cost, on a basis of 100 vehicles, would be $2,349 million, or $110 per lb. of payload in orbit.

Big pitch for the all-solid concept is simplicity and high production rate with relatively low costs. Vehicle C, for instance, consists of 147 identical propulsion units, 28 identical nozzles, 58 identical case heads and 29 identical caps. The loaded cylinders would be transportable by truck, rail, or air.

• **Communications satellites** — A wide divergence of opinion as to the most practical communication satellites was evident at the meeting.

A proposal by a Hughes Aircraft Co. scientist for a privately launched 24-hour satellite drew potshots during a panel session. H. A. Rosen, of Hughes, wants to launch the satellite with a *Scout* vehicle from Jarvis Island, an American-owned island 1300 miles south of Honolulu, near the equator.

J. R. Pierce of Bell Telephone Labs said Bell prefers low-altitude active repeater satellites because of the echo problem in a transmission of 45,000 miles (for a 24-hr. satellite) and to get improved signal strength.

Both Bell and Hughes expect to have satellites ready for launching next fall.

Edward Allen, chief engineer of the FCC, said he was confident that radio frequency spectrum space will be found for experimental and operational communication satellite systems.

• **Underwater propulsion**—A novel underwater propulsion unit developed by Naval Ordnance Test Station was described in a paper by W. D. White. Either liquid sodium or lithium is used as a fuel and sea water as oxidizer and dilutent in the unit remarkably blueprinted by Jules Verne. (In "20,000 Leagues Under the Sea," Verne called for sodium to power his fictional Nautilus.)

Theoretical and experimental work has shown that a specific fuel consumpsion of 1.5 lbs. per shaft-horsepower hour is possible with the use of lithium, and less with sodium. A combustion chamber for burning these fuels was developed and operated for three minutes at 95% combustion efficiency and at about 1000°F.

• **Ground support equipment**—Literally the biggest item of GSE discussed at the ARS meeting was that for *Saturn.* Pointing out that a program of this magnitude cannot tolerate any failures due to the GSE, Georg von Tiesenhausen of Redstone Arsenal said that lack of precedent and stringent time schedules put an unusually heavy responsibility on the GSE project engineer. Problems have been solved, however, he said, and the equipment now stands ready to transport, check out, and launch the *Saturn.*

Space suits for lunar explorers are now *passé,* according to a paper presented by two AMF scientists. They contended that research shows that robots and one- and three-man articulated capsules would be more practical for the moon explorer than individual space suits.

A Boeing engineer, describing silo launch tests of the *Minuteman,* said that this phase of the program was ahead of schedule and required only two-thirds the number of firings originally planned. Success was attributed to "thorough analytical preparation" and "exceptional success" in data acquisition.

• **Advanced materials**—High-temperature materials dominated the structures section of the meeting. R. T. Swann of NASA took the position that re-entry heating conditions can best be met by composite systems. Swann analyzed simple and composite systems in relation to weight and found that the latter would require less weight for all heating conditions.

Another approach involving the application of organic plastics in achieving an effective re-entry heat barrier was advanced by B. Forcht and M. Rudick of Chance Vought. The essence of the system is the development of a char layer on leading surfaces. The speakers said it would be possible to tailor a wide variety of composites of reinforced carbonaceous materials —with the necessary properties designed into the structures.

A. R. Maloof described Avco RAD's family of tungsten-based composites which are capable of operating above the melting point of tungsten. Designated Avcomet, the material is particularly suited to withstanding the high heat fluxes found in the throats of present and future full-scale rocket nozzles.

An interesting concept in reinforced

(Continued on Page 48)

Another "impossible" job done by the Airbrasive...

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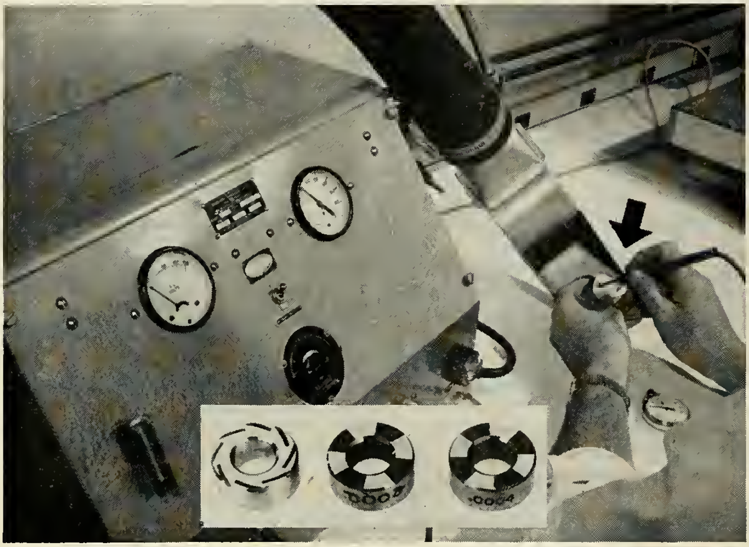

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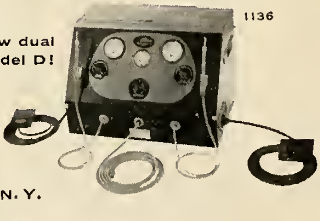

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Civil Defense

(Continued from Page 17)

support of Tactical Command in a brushfire war.

In the event of nuclear attack, the U.S. Defense Command would mobilize to save lives, maintain order, and get the country going again. In this set-up, the present Civil Defense (shorn of useless job-holders) would became the Military Government section of the Command. It would include police, fire-fighters, and CBR teams.

Some National Guard generals dislike the thought of this mission. But let's face it, if we are ever clobbered by nuclear-tipped rockets, members of the National Guard will be fortunate to get to their armories, much less gather in encampments to be shipped overseas as part of an expeditionary force.

• **Stay home and survive**—Drastic revision of present civil defense tactics must take place to give the people a realistic hope for survival.

The key to American civil defense is a national home shelter program, coupled with fast and secure communications, truthful information swiftly relayed to the public, and accurate radiation data. Our situation is different from Russia's. We are committed to receive the first blow, which means we probably will have no chance to evacuate the great cities. Our population centers are more vulnerable than Russia's. Russian targets are dispersed over the whole continent of Asia. So home shelters are the answer for America.

In a surprise attack on our unprepared population today, radiation would kill more people than heat and blast. An adequate home shelter program, privately financed with Federal encouragement, would save most of those who otherwise would die.

Evacuation of cities can be effective only if the populace receives considerable advance notice of impending war. In the event of a pre-emptive strike—which is what we must expect—evacuation would only compound chaos.

• **Swimming pools come first**—Thus far, our shelter program has been a fiasco. In Orlando, Fla., for example, a company specializes in home shelter construction. Florida is more sensitive to the need for shelters than most states, perhaps because of its proximity to Castro's Cuba, and the fact in Florida are so many SAC bases and Navy air installations. Yet this company is struggling, while builders of swimming pools prosper. Hundreds of pools are sunk for every shelter.

In a Florida town, the County Civil Defense Director was asked whether he had any new booklets on fallout. "I had them," he said, proudly, "but I got rid of 'em. Scare people to death if I passed them out!"

• **What government can do**—If the Federal government is really serious about saving the civilian population, it must give concrete encouragement to a home shelter program. The following measures have been presented to the Symington Committee for consideration:

1. Everyone receiving an FHA or VA loan for construction of a new dwelling must agree to include a shelter. Every FHA loan for remodelling should include a similar clause.

2. Cost of shelter construction, either in old or new buildings, should be allowed as a tax deduction, once the shelter has been approved by U.S. Defense Command inspectors.

3. Shelters can be used for dual purpose, such as utility or storage rooms, and this should be encouraged. In many cities parking garages are being built underneath new apartment houses, and will serve a double purpose as a shelter.

4. (And perhaps most important.) Tell people the truth about what nuclear war and fallout means to them, personally. It should be emphasized that they can survive (barring a direct hit within a few miles) and that it is their duty to survive. They have a duty to themselves, their children, and their country. Much apathy is caused by a sense of fatalism and resignation. You hear statements like, "Everybody's going to die anyway," or "I'd rather be dead than lose everything I've worked so hard for."

5. If filling stations and chain stores can afford to pass out trading stamps to their customers, than the Federal government can and should donate a simple, sturdy dosimeter to everyone who spends his cash on a home shelter. Without a dosimeter, you can't tell the score. Fallout varies wildly within a few miles, and an official testing station in the next big town may give you a wrong answer.

These seem minimum requirements for encouraging construction of home shelters. For a realistic civil defense program, other immediate measures are necessary.

• **Conelrad's obsolescence**—Conelrad should be scrapped at once. It no longer serves any useful purpose and indeed may inhibit exchange of news and information within the country.

Conelrad was started in 1948, at the request of the Air Force, to prevent enemy bombers from finding a target city by homing on a radio station. All

(Continued on Page 40)

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NEW CAREER OPPORTUNITIES FOR ENGINEERS & PHYSICISTS

Expanding requirements of Pan Am's Guided Missiles Range Division have created new career positions for Electronic Engineers, Systems Engineers and Physicists with B.S., M.S., and Ph.D. degrees with experience in one or more of the following fields:

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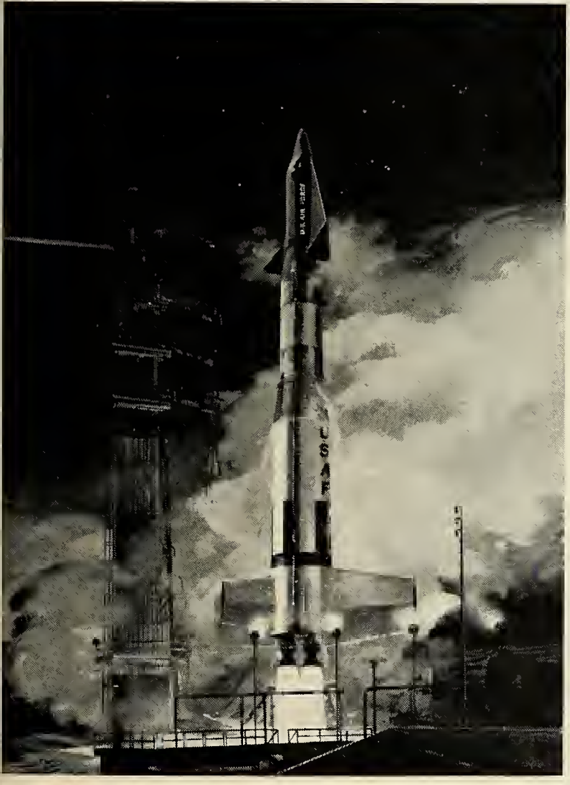
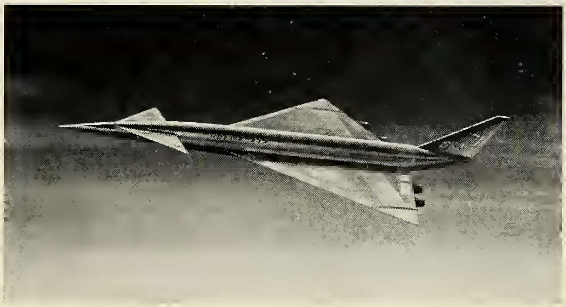
BULLETIN FROM BOEING..

...WHERE CAPABILITY HAS MANY FACES

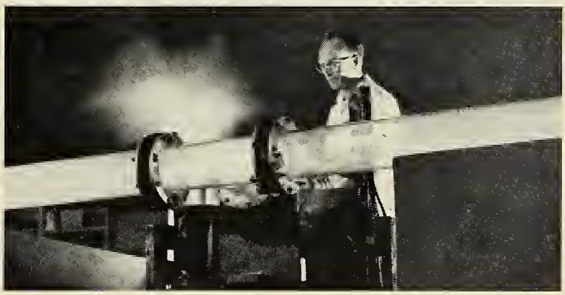
Expanding the frontiers of knowledge through basic research is the business of the Boeing Scientific Research Laboratories, left. Here Boeing scientists are at work in the fields of solid state physics, flight sciences, advanced mathematics, plasma physics and geo-astrophysics.



SPACE GLIDER. Artist's concept shows Dyna Soar manned space glider perched atop modified Titan ICBM for launching. In space, the glider and booster would separate, leaving Dyna Soar vehicle in piloted, near-orbital flight. Pilot could later glide to conventional landing at a selected base. Dyna Soar is being developed by the U. S. Air Force in cooperation with NASA, with Boeing as prime contractor for both the system and the glider.



FUTURE SKYLINER. Boeing, builder of famous 707, America's first jet airliner, has long been at work on next generation of aerial transports, which could look like the Boeing design pictured above. Supersonic jetliners, probably a decade away, could have speed in neighborhood of 2,000 miles an hour. Flight time, from Paris to New York, would be about two and a half hours!



SHOCK TUBE. Industry's most powerful shock tube, designed and built by Boeing Scientific Research Laboratories scientists, creates shock waves which begin at 300 times speed of sound, then collide in tube at "slowed" rate of 80 times speed of sound. Gas temperature within the tube reaches approximately one million degrees. Studies could be important in developing effective ion and plasma-propulsion systems for use in space.

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(Continued from Page 37)

Russian bombers are now equipped with modern radar. They don't have to tune in WJZ or WTOP to locate New York or Washington. Rockets, guided and unguided, do not find it necessary to listen to the radio to hit their targets.

In the event of war emergency, all commercial television and all radio except those transmitters on the Conelrad frequencies would cease operations, under present plans. Conelrad broadcasts on very low power, alternating transmitters. As a result, it is often difficult to hear Conelrad broadcasts at all.

In place of Conelrad, powerful clear channel stations should be designated to carry news and instructions to the populace. Anything, including operation of all surviving transmitters, would be better than Conelrad.

- **Keep news flowing**—All radio stations presently receive their news from the Associated Press and United Press International on teletype machines. The main originating and relay points for the two big news agencies are New York, Washington, and Los Angeles, all primary target cities. The biggest AP and UPI bureaus are in those and other of our largest cities, such as Chicago, Houston, Philadelphia, Miami, Detroit, Pittsburgh.

Thirty minutes after attack our major news networks probably would have ceased functioning. The local radio stations would be supplied with news from local officials. Such news would certainly be delayed, and probably inaccurate. Lack of news breeds rumor, and rumor breeds panic. The government should immediately lay an auxiliary news network, avoiding the target cities, which would be available to AP and UPI come "The Day."

Our lag in civil defense is an open invitation to attack. A realistic U.S. Defense Command would be added deterrent against war. It may seem strange, but the officers and men of SAC seem more concerned with the problem than any other group in the services. It is strange until you consider that the men of SAC know the power of the bomb, intimately, and their families are usually close to targets. ⌘

Pat Frank is the author of many books, articles and short stories dealing with survival in a nuclear war; his most recent is the novel Alas, Babylon. *He is also a former Washington reporter and World War II correspondent. He carried out several wartime propaganda assignments for the U.S. Government and for the U.N. in Korea. During the recent presidential campaign, he was an advisor to President-elect Kennedy.*

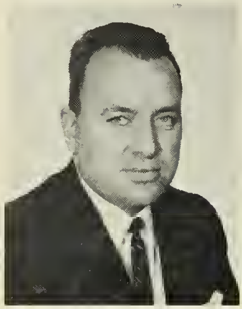
←Circle No. 15 on Subscriber Service Card.

SPRINGBOARD FOR SPACE: LUNA

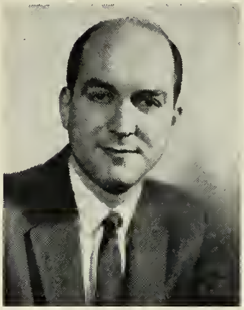
The moon is a ready-made space station for interplanetary exploration; space vehicles could be built, fueled, and launched there; lunar elements could be used to give man independence from earth. To help make this concept a reality, NAA's Missile Division has integrated the ideas of scientists in many fields and is studying how to reach the moon...how to live in its alien climate...how to process lunar matter. One example: a study of processes to obtain water from materials likely to be found on the moon.

THE MISSILE DIVISION OF
NORTH AMERICAN AVIATION, INC.
Downey, California

names in the news



MADESON



de MORAES

DEROSA

Ernest L. Ward: Elected president of Sprague Electric Co. replacing the late **Julian K. Sprague.** Ward joined the firm in 1946 as a vice president, was elected to the board of directors in 1947 and, in 1953 was appointed executive vice president in charge of all manufacturing activities.

Dr. Henry Swift: Appointed assistant director of the infrared laboratory at Hughes Aircraft Co.'s Santa Barbara Research Center. Prior to joining Hughes he was an associate director of the Naval Aviation Ordnance Dept. at China Lake, Calif.

Dr. Seymour Stein and **Dr. James E. Storer:** Promoted to senior scientists at Sylvania Electric Products Inc.'s Applied Research Laboratory. They are the first to achieve that position with GT&E.

Andrew L. Larson: Appointed manager of Navy Sales for Lockheed Electronics Co.'s Military Systems Division. Formerly served as a project engineer in the Shipboard Electronics Dept.

Darrell D. DonCarlos: Named manager of by-pass engines and rocket sales for the Allison Div. of General Motors. He replaces **Richard L. Coffey,** appointed manager of the division's Los Angeles zone office.

Joseph M. Rowland, Fred E. Hamlin: Named Corporate Director of Public Affairs and Director of Communications, respectively, at The Martin Co. Rowland was formerly Corporate Director of Information Services and Advertising, and Hamlin Director of Information Services for the Baltimore division.

Austen Madeson: Elected vice president-marketing for Solid State Materials Corp. Prior to joining the firm he was sales manager of the Crystal Filter Div. of Hermes Electronics Co., a division of Itek Corp.

Dr. Samuel Sensiper and **Dr. William Pohlman:** Appointed director and associate director, respectively, of Space Electronics Corp.'s newly formed Command and Control Laboratories. Dr. Sensiper comes from Hughes Aircraft Co. where he served as senior staff consultant in the Research Laboratory and Dr. Pohlman previously served as associate director of systems for the western division of Collins Radio.

Carlos de Moraes: Named program manager of The Martin Co.'s *Apollo* study contract with the National Aeronautics and Space Administration. De Moraes was Martin project engineer for the Air Force *Dyna-Soar* manned aerospace glide vehicle program.

Aaron Blaustein: Appointed chief research and development engineer of De-Jur-Amsco Corp.'s new Research and Development Dept. Was formerly associated with Fairchild Controls Corp. as new products program chief engineer.

George H. Mettler: Elected vice president of Textron Inc. **Charles D. Brown,** former manager-marketing of General Electric Co.'s Instrument Dept., succeeds Mettler as president of MB Electronics, a division of Textron Electronics, Inc.

Carl C. McCallus: Named director of marketing, a newly-created position at Viking Industries Inc. Was formerly director of marketing for Phillip Morris, Inc., and sales manager of Hoffman Electronics Corp.'s Electromechanical Div.

Quentin G. Turner: Chosen at Motorola Inc. to head all managerial aspects of development and production of the M.&T.C. major weapons system for the New North American B-70 triple-sonic global bomber. He will retain his position as assistant manager of Motorola's Western Center.

Henry M. DeRosa: Appointed vice president in charge of marketing for Vector Manufacturing Co. Inc., manufacturers of telemetering components and systems. Was previously associated with Long Island City Co., Infra Electronic Corp., W. L. Maxson Corp. and Bendix Aviation Corp.

Dr. Gordon S. Brown: Dean of the Massachusetts Institute of Technology's School of Engineering, elected to the Board of Directors of Baird-Atomic, Inc.

Dyna-Soar Safety

(Continued from page 29)

• **Drainage**—The technical area of glider drainage of combustible leakage is one in which a considerable effort must be expended. Fluid behavior under zero gravity conditions may necessitate development of specialized drainage systems to insure adequate drainage under all *Dyna-Soar* flight conditions. The complexities of such systems have placed greater emphasis on development of leakproof fluid systems; with the operational environment extremes to be encountered, however, a certain leakage must be anticipated.

It is a design objective to prevent leaking fuels from contacting ignition sources. Among the prevention techniques to be practiced is isolation of combustible areas and protection of potential ignition sources through measures such as maximum use of circuit breakers to prevent electrical circuit overloads and cooling provisions for areas which normally might exceed the autogenous ignition temperature of the leaking fluid.

Design safety approaches to the completing portions of the *Dyna-Soar* system—namely the booster, launch complex, support equipment, and test range—are not unique in themselves but rather are the outgrowth of a tremendous volume of development and service experience.

The booster safety effort for the *Dyna-Soar* program is under the management responsibility of the *Dyna-Soar* Booster Office at BMD. Current efforts in this area include an appraisal of the *Titan* configuration and its suitability for use in manned applications. High reliability has been obtained thus far in the *Titan* ICBM development program. But the modifications to the booster necessary to accommodate the glider must be analyzed to determine their influence on the overall safety and reliability of the booster.

Candidate boosters for future steps of the *Dyna-Soar* program are being investigated. Since these boosters are in the early development phases, the *Dyna-Soar* Engineering Office hopes to contribute to a design safety effort on these vehicles by familiarizing the contractors with the *Dyna-Soar* program and the safety emphasis which is essential in the piloted advanced research system of this type.

The primary protection system in the booster is the malfunction detection system. This is incorporated to monitor selected critical parameters in the booster. Output from these monitor sensors will be summed in

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a logic circuit and if conditions warrant, a signal to initiate escape action will be sent to the control center. A suitable failure detecting system will include a monitoring of critical items within electrical, flight control, propulsion and tankage systems.

The engineering groups in each of these areas have formulated the sensing requirements for each of their systems. Since it is a research program, each subsystem has been heavily instrumented. To insure that an efficient malfunction detection system is selected, the safety engineer must determine what abnormal operations would produce hazardous sequential failures, what available instrumentation could be tied into the malfunction detection system, and which complementary detection devices are required. From this analysis effort a malfunction detection system for the *Dyna-Soar* will be designed to advise the pilot of a pending catastrophic failure and permit automatic or pilot-initiated escape action.

Safety of operations at the launch site and test range will be emphasized through issuance of safety directives to cover each phase of the *Dyna-Soar* flight test program. Excellent information has been prepared for current safety programs at Cape Canaveral and will be used as a guide in establishing the program.

• **Premium is on cooperation**—In the preceding comments, I have attempted to outline the various phases of our program and the precautions being considered to insure that our flight exploration is accomplished with the utmost in safety for man and material. Neither one man, one section, one division, nor one command can make the necessary effort alone. Cooperation must be emphasized; everyone who contributes to the *Dyna-Soar* program must develop an awareness of the hazards involved.

Thousands of individual safety campaigns must be waged if this country is to successfully conquer the challenge of space. A safety program is never completed but must continue throughout the life of the system. As the *Dyna-Soar* program progresses, unique hazards will develop and means of neutralizing them must be found. Technology in the area of development and operational safety must proceed at a pace paralleling advancements in propulsion, high-temperature materials, and other essential areas. The *Dyna-Soar* program is attempting to meet this challenge. Subsequent advanced systems programs must continue this effort. ⌘

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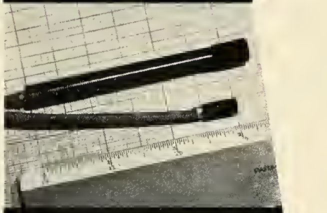

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Operating pressure: 2500 psi — Temperatures up to 650°F Maximum. Design hydrostatic pressure rating — 3,750 psi.

Valve manufactured by Crosby Valve & Gage Co., Wrentham, Massachusetts.

The valve and bellows shown here team together to control pressurized water in a nuclear power plant. This hermetically sealed combination steam and hot water valve protects the main coolant system of the primary loop.

The welded diaphragm bellows of inconel construction combines maximum physical properties with excellent corrosion resistance to sea water. Forming an integral part of the relief valve, the bellows serves as a balancing and sealing member assuring proper valve operation on high pressure steam and hot water under conditions of varying discharge pressure and high flashing.

Assure dependable valve sealing with welded bellows engineered and manufactured by Metal Bellows Corporation. All inquiries given "on-the-spot" attention in full detail.

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contracts

AIR FORCE

$65,000,000—Hughes Aircraft Co., Culver City, Calif., for production of the *GAR-11 Nuclear Falcon*, the radar-guided *GAR-3A* and the infrared-seeking GAR-4A *Super Falcon*.

$6,000,000—Ling-Temco Electronics, Inc., Temco Missiles & Aircraft Div., for manufacturing major components for the B-52H manned missile-launching platform. Subcontract from Boeing Airplane Co.'s Wichita Div.

$1,100,000—Sperry Gyroscope Co., for flight computer directors.

$689,479—Collins Radio Co., for horizontal situation indicators and amplifiers.

NASA

$31,000,000—Linde Co., Div. of Union Carbide Corp., for liquid hydrogen to be used in future space projects on the West Coast. Linde will deliver liquid hydrogen to the West Coast from an Air Force plant at West Palm Beach, Fla., until a new company plant at Fontana, Calif., gets into production in mid-1962.

ARMY

Tele-Dynamics Div., American Bosch Arma Corp., Philadelphia, for study of low-level wind measuring techniques. Amount not disclosed.

$20,428,000—The Martin Co., Orlando, for continuation of engineering services and development of long lead-time equipment for the *Pershing* system.

$2,250,000—Raytheon Co., Bedford, Mass., for further research and development work on the *Hawk* system.

$1,900,000—Fairchild Engine & Airplane Corp., Hagerstown, Md., for AN/USD-5 drone surveillance system.

NAVY

Custom Systems Corp., Santa Ana, Calif., for production of special underwater electrical cable systems. Amount not disclosed.

reviews

PROCEEDINGS OF THE 1959 COMPUTER APPLICATIONS SYMPOSIUM, Armour Research Foundation of Illinois Institute of Technology, sponsors. 155 pp., $3. Order from Armour Research Foundation, MF:CA6, 10 West 35th St., Chicago 16, Illinois.

The Proceedings contain 14 invited papers presented at a two-day meeting in Chicago, and the edited text of the associated discussions. The first day's papers were devoted to business and management applications, and those on the following day stressed engineering and scientific applications.

Several themes were represented. One was the development of methodology of general interest to exploit the capabilities of specific machines, large to small. Another was the extension of a general-purpose computer's resources by means of specialized input-output and display equipment to handle graphical information.

The largest group of papers, and a considerable portion of the panel discussions, were addressed to the question: Now that we have the machines, how do we communicate with them? The answers centered around the pros and cons of automatic programing and language design. Finally, there is a report on the current status of computer technology in the U.S.S.R.

EMBRITTLEMENT BY LIQUID METALS, W. Rostoker, J. M. McCaughey and H. Markus. Reinhold Publishing Corp., N.Y., 162 pp., $7.95.

A new approach to embrittlement by liquid metals based on modern dislocation theories of brittle fractures emerges from this synthesis of the vast amount of information in the field.

The aggregate knowledge in the literature was found to be inadequate and often inaccurate. The authors enlarged upon this store through research sponsored by the Army. Most of the information in the volume has not been published previously since the authors felt that presentation in the usual journals would result in incomplete and inadequately correlated communication.

Radar/Transponder Checkout Units

An airborne test set designed for pre-flight or in-flight checkout of IFF transponders or ATC radar beacon performance is available from Stromberg-Carlson, a division of General Dynamics Corp.

Designated Model SC-770, the test set provides a "go" or "no-go" indication of transponder operation. It is compact in size, weighing less than 3 pounds, and consists of two parts—the basic interrogator circuitry, and the control box for instrument panel mounting.

To operate the test set it is merely necessary to push a button on the control box, which interrogates the transponder. A satisfactory response from the transponder will cause indicator lamps to flash. Use of solid state devices in the unit keeps power requirements extremely low.

Circle No. 225 on Subscriber Service Card.

Portable Ozone Recorder

A portable ozone recorder, available from Mast Development Co., measures and records ozone concentrations on a 6 in. strip chart.

The instrument's major components are the Model 724-1 Ozone Meter, a strip chart recorder and a weatherproof case. The weatherproof case enables stationing the ozone meter at remote outdoor locations with the strip chart recorder located in the laboratory for observation. The unit employs a highly efficient Micro-Coulomb sensor which eliminates buffer solution composition criticality.

Circle No. 226 on Subscriber Service Card.

Single Side Strain Gage

A bending-separator gage which will separate and identify tensile strains and strains produced by bending moments on the surface of a structure is available from The Budd Co.

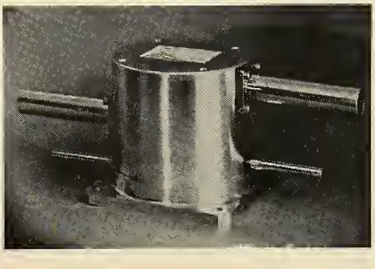
Major feature of the device, called FLEXAGAGE, is that it can be mounted on one side of a structure only.

FLEXAGAGES can do all jobs of back-to-back mounted strain gages, including: locating the neutral axis of the shell-skin-plate and detect buckling. Maximum error without correction factors for gages used as specified is 2%.

Circle No. 227 on Subscriber Service Card.

Pressure Regulator

A precision gas regulator which controls pressure at any selected remote point in a pumping system is available from Del Monte Technical Associates.



The Mark II Pressure Regulator is a self-contained, instrument quality device which can be used in both vacuum and pressure applications. Regulation is typically within ±0.1 mm Hg from minute rates of flow up to 30 cfm.

Circle No. 228 on Subscriber Service Card.

Subcarrier Oscillator

A transistorized subcarrier oscillator designed for operation from millivolt signals and having a transformer-coupled, floating input is available from Electro-Mechanical Research, Inc. Model 199B is designed for reliable operation in FM telemetering systems incorporated in missile or aircraft environments.

The oscillator operates in any IRIG-standard telemetry channel from 2.3 to 22 kc. Frequency deviation is a linear function of input voltage within ±0.2% of the best straight line on IRIG channels 7-14. Common-mode rejection is better than 100 db.

Circle No. 229 on Subscriber Service Card.

Space Heating Elements

A film type, inorganic heating element, is available from Thermo-O-Lab Corp. It does not out-gas in a vacuum and it is stable at –400°F. The element does not glow or support combustion.

Only .015 in. thick, it is sprayed on to any shape. It is completely inorganic; and acceleration, vibration, radiation and cryogenic temperatures provide no problem.

Circle No. 230 on Subscriber Service Card.

Miniature Clutch

A high-efficiency miniature magnetic clutch with a minimum torque rating of 10 ounce-inches at speeds to 1000 rpm is available in four voltage ranges from Ultronix, Inc.

The firm's Model 162 clutch is stocked in 6, 12, 28 and 90 volt ranges, all operating at 2.5 watts. The unit occupies about 1 cubic inch. Torque loss with stainless ball bearings is less than 0.3 ounce-inch. Field shaping and the steel-to-brass clutch face enables the clutch to deliver up to 15 ounce-inches to the load at 2.5 watts.

Circle No. 231 on Subscriber Service Card.

Plasma Gun Convertor

A conversion kit which permits the modification of any standard Plasmatron SG-1 hand held plasma spray gun to variable arc temperature use is available from Plasmadyne Corp., a subsidiary of Giannini Scientific Corp.

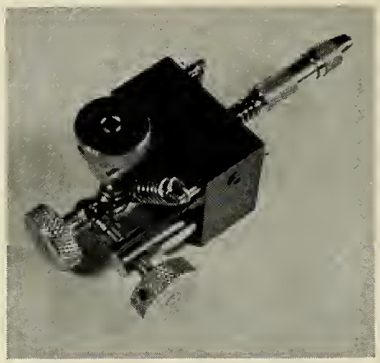
The kit permits adjusting the jet temperature between 300°F. and 30,000°F., by changing the distance the adjustable rear electrode projects into the throat of the front electrode and by adjusting the insulated rod to which the rear electrode is mounted.

Circle No. 232 on Subscriber Service Card.

Wafer Manipulators

The Micromanipulator Co. has available models 100 (right hand) and 200 (left hand) micromanipulators—useful in semiconductor and related work for the precision positioning and probing of wafers and microelectronic assemblies. Accessories include tungsten probes and phenolic insulating jaws.

Circle No. 233 on Subscriber Service Card.



Low Frequency Absorbers

McMillan Industrial Corp. is marketing TYPES BB and BP broadbanded absorbers providing effective attenuation in free space room installations from 35,000 mc/s down to as low as 50 mc/s in the case of the BB-96.

Major advantages are: elimination of any supporting structure; a reduction in cost per unit volume of absorber, rugged, fire-resistant construction, and reduction of shipping and storage space (and hence cost), since in shipment they occupy a fraction of their installed volume.

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Miniature Relief Valve

Benbow Manufacturing has available an inverted design miniature relief valve which eliminates over-travel, chatter and slamming while maintaining desired system pressure.

Specifications exceed requirements of MIL-V-5523 with zero leakage internally; 100-PSI to 4000 PSI with wide adjustment; flow rate 0.5 to 6 GPM; temperature range –65 to +250°F.

Circle No. 235 on Subscriber Service Card.

Motionless Explosive Switch

An adaptable miniature explosive switch with no moving parts is available from Mimx Corp. The unit has a reliability factor of 99.997%, and is unaffected by normal missile environments.

The action of an explosive charge establishes a large-area permanent contact, providing virtually failure-proof

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PYROGENS: Somewhat new to the industry are igniters for rockets and gas generators characterized by controlled production of ignition gases. These, too, are *shelf items* from Propellex — immediately available for your next project.

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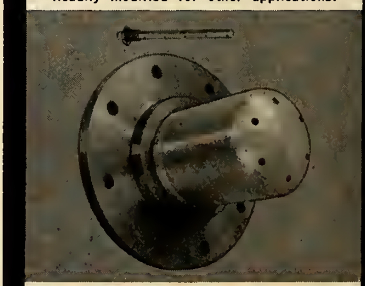
MODEL 99 ROCKET. Designed by Propellex for McDonnell Aircraft feasibility study on small weapons systems propulsion units. Readily modified for other applications.



MODEL 90 PYROGEN. Designed and developed by Propellex for United Technology Corporation. Low in cost due to simple design. Easily modified to produce different mass flow rates as required.

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completion of the circuit. The switch will withstand unlimited G-force, shock and vibration, both before and after contact is completed.

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Isolated Input Amplifier

A floating differential DC amplifier which provides complete isolation of input signal from amplifier output and chassis ground is available from Neff Instrument Corp.

Designed specifically for amplification of DC signals from strain gages, thermocouples, and bridge-type transducers, the new Type 1-104 Amplifier offers Common Mode rejection of 180 db at DC, 130 db at 60 cycles with up to 1000 ohms line unbalance. Stability is 5 microvolts over a six-month period.

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Navy Standard Containers

All 28 sizes of the Navy's standardized aluminum containers are available from Zero Manufacturing Co. They are constructed to Navy BUWEPS Drawing List 2210448 and also meet specifications of MIL-T-945A, MIL-T-21200. These containers are equipped with standard latches, pressure equalizers and humidity indicators. Easy to accessorize, they are readily adaptable for other uses where rugged, watertight, air-tight containers are required.

Circle No. 238 on Subscriber Service Card.

Acceleration Switch

A model AS-4 switch is responsive to acceleration in one direction along a single axis, is available from Eastern Technical Associates. Resetting is by means of high acceleration in the opposite direction or manual reset. The design is rugged and simple consisting of only one moving unit within the switch housing. The housing is constructed of aluminum and interior construction can be of non-magnetic materials resulting in a completely non-magnetic component.

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Compact Recorder

A compact, lightweight 8.5 x 11 in. X-Y recorder is being marketed by F. L. Moseley Co. Model 135 features built-in calibrated X-axis time sweeps, plus 16 calibrated ranges on each axis, with an infinitely variable vernier. The Model 135 features high input resistance, a self-contained vacuum paper hold-down, full range calibrated zero set and zero suppression on each axis, plus high recording speed.

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actual size

BRISTOL chopper helps put Navy TARTAR on target

. . . Every component in the U.S. Navy's TARTAR, newest supersonic surface-to-air guided missile must meet the highest standards for statistical reliability.

No exception is the Bristol Syncroverter* chopper used in the TARTAR's guidance system. The TARTAR, produced for the Bureau of Naval Weapons by Convair (Pomona) Division of General Dynamics Corporation, is slated to form the primary antiaircraft weapon aboard destroyers and secondary antiaircraft batteries aboard cruisers.

The Bristol Syncroverter chopper has a long history as a component in U.S. guided missiles. It's the ideal miniature electromechanical chopper for use in d-c analog computers or wherever utmost reliability is required.

BILLIONS OF OPERATIONS have been completed without a failure on Bristol's continuing life tests—aimed at improving the Syncroverter's already superlative characteristics. Just one sample: A group of five choppers, with 400 cps drive and 12v, 1 ma resistive contact load have been going for more than 26,000 hours without failure. That's more than 2.96 years continuous operation or more than 37 billion complete cycles!

No matter what your chopper requirements, we're sure you can find the model you need among the wide selection of Syncroverter choppers and high-speed relays available . . . including low-noise, external coil types. For complete data, write: The Bristol Company, Aircraft Equipment Division, 150 Bristol Road, Waterbury 20, Conn. 0.15

*T.M. Reg. U.S. Pat. Off.

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LONG RANGE INPUT / 1794

News of the recapture of Condé from the Austrians was sped to the French Revolutionary Convention at Paris in a matter of minutes via Claude Chappe's amazing télégraphe aérienne, or relay aerial telegraph, Sept. 1, 1794. A new era in rapid communications had begun.

Today, instantaneous and completely reliable Electronic Communications insure the immediate and continuous interchange of intelligence throughout the Free World. ECI is proud of its initiative and responsibilities in the design, development and manufacture of high precision electronic equipment to the critical specifications required in various aerospace and surface roles vital to our National Defense and to scientific achievement. An example is ALRI—Airborne Long Range Input—a program where ECI communications and data link equipment fill an integral and essential requirement in linking USAF's advanced early warning system to SAGE—our continental defense network.

One of a series depicting historic incidents in military communications

The Bettmann Archive

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ARS Technical

(Continued from Page 35)

plastic art was presented by I. Gruntfest and N. Dow of General Electric MSVD. They proposed replacing the usual solid-glass fiber with hollow glass of comparable outside diameter.

- **Navigation and guidance**—The use of favorable geometric properties of lower-magnitude star distribution over the celestial sphere was proposed by N. S. Potter of W. L. Maxon Corp. as a solution to certain weaknesses (such as tumbling) in conventional star-tracking techniques for sensing in inertial space.

The 157-lb. inertial system developed by Minneapolis-Honeywell and Librascope for *Centaur* injection guidance was described as providing high accuracy, broad mission flexibility, and complete vehicle attitude and coast freedom—all with minimum cost and developmental time. The 32-lb. inertial platform is a 4-gimbal platform with three one-degree-of-freedom gyros. Other units include an 18-lb. guidance electronics unit, 50-lb. pulse-rebalance and power supply package, 10-lb. signal conditioner (for telemetry), and a 57-lb. digital magnetic-drum computer.

Saturn-boosted space vehicles will use the Delta-Minimum inertial guidance system developed for *Redstone* and *Jupiter*, according to a paper delivered by W. Haeussermann, of NASA. It was chosen, he said, because its proven accuracy and reliability were essential to meet the "almost universal" requirements of the *Saturn* vehicle.

SATRAC (Satellite Automatic Terminal Rendezvous and Coupling) was proposed by Convair's L. J. Kamm for the automatic guidance, soft impact, and connection of two space vehicles, manned or unmanned. Primarily optical, the homing system would employ pulsating lamps mounted on booms set at right angles to the flight path. ⌘

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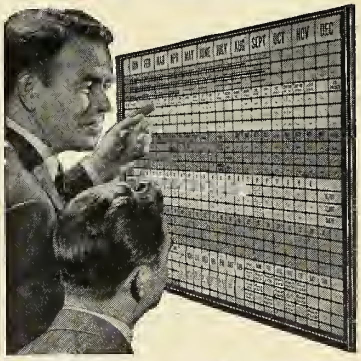

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Space Communications Outlook Garbled

WITH THE CONVENING of Congress in January, the Senate Committee on Astronautical and Space Sciences can be expected to take a long, hard look at America's position with regard to international space communications.

It is probable, we have learned, that hearings will be held as a follow-up to the Committee's staff report on Policy Planning for Space Telecommunications which was released last week.

If the voluminous report (207 pages) indicated any one thing clearly it was that the U.S. communications situation is confused; that it will continue to get more confused unless some heroic step is taken to combine or centralize the authority (and lack of it) which is now scattered between a number of boards, committees and commissions.

Among the possible peaceful applications of space, two stand out. One is global communications. The other is weather forecasting. And the former plays a great part in the latter.

Neither of these programs is spectacular. Neither puts a man in space or aims at the moon (at least not immediately). But both are eminently important. Both have military applications but both also have applications for other government agencies and for commercial users.

Without coordination there is the great possibility that we may, in our preoccupation with details, miss the bigger things, especially those in the communications field.

With the release of the Senate Space Committee report came the announcement from NASA that the space agency would enter the field of active communication satellites. In the past NASA has confined its activities to passive types (the *Echo* balloon) and left the repeater satellite field to the Department of Defense.

In addition, NASA said: " . . . support will be given to technically promising private proposals on a cost-reimbursable basis. This means that NASA will, to the extent of its statutory authority, make vehicles, launching and tracking facilities and technical services available at cost to private companies, provided the private plans for the development and commercial utilization of communication satellites are technically promising and in general consonance with the requirements of other licensing bodies."

We would not for a moment doubt that everyone involved in the U.S. space communications area has the best of intentions.

WE WOULD POINT OUT, however, that at this moment the responsibility for the planning and aiding of such communications is divided between—to name some—NASA, Defense, State, Bureau of Budget, the Federal Communications Commission, Civil Defense, the U.S. Information Agency, the Telecommunications Coordinating Committee and the Interdepartment Radio Advisory Committee.

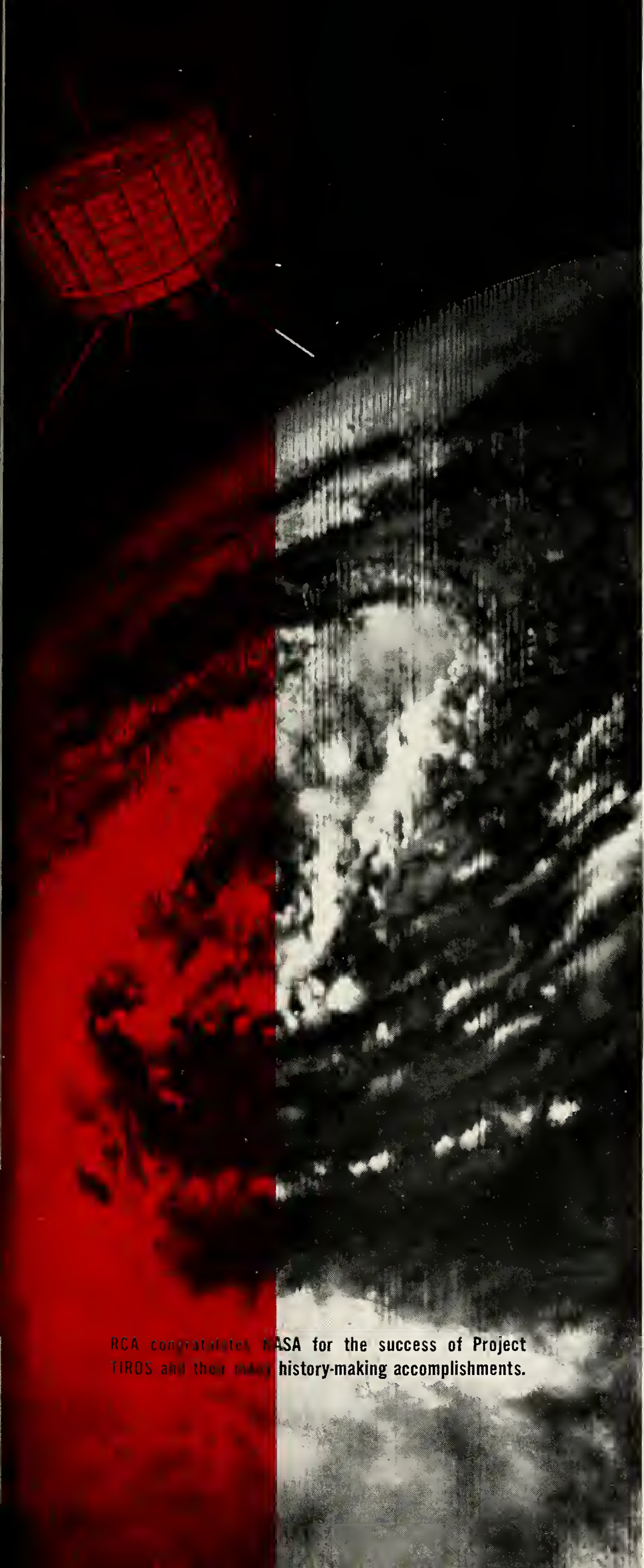
We would also suggest that there is no one office at White House level (from where else could such a group be commanded?) which establishes policy and priorities for space communications. We further suggest that there should be.

All of the agencies named are bureaucratic. And men in bureaucratic agencies tend to act like bureaucrats unless someone higher pushes, prods and cracks a whip.

The President's Space Policy Committee might have fulfilled this requirement—if it had been made to function as the Congress intended it to. It never has.

To this void, to this delinquency in our space program, we invite the attention of the Senate Space Committee and the Chairman who will succeed Vice President-elect Lyndon Johnson. It is a rich field for inquiry.

Clarke Newlon



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Tiros II satellite, like Tiros I, was designed, developed and built by RCA's Astro-Electronics Division for the National Aeronautics and Space Administration. It includes all of the equipment of TIROS I—TV cameras, tape recorders, TV transmitters, command receivers, timing mechanisms, beacons and telemetry equipment—plus many new and improved devices. Chief among these are:

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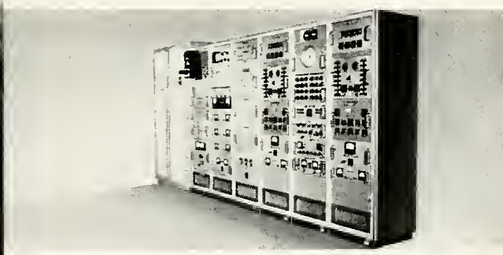

Ground stations for TIROS II were designed and developed by RCA. This includes the primary stations at Fort Monmouth, N. J., at the Pacific Missile Range and the back-up stations at Princeton, N. J. and Cape Canaveral, Florida.

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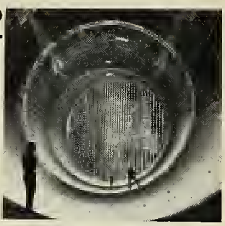

Interior of Air Force's Propulsion Wind Tunnel at the Arnold Center, Tullahoma, Tenn., providing first space environment testing for whole vehicles. See p. 14.

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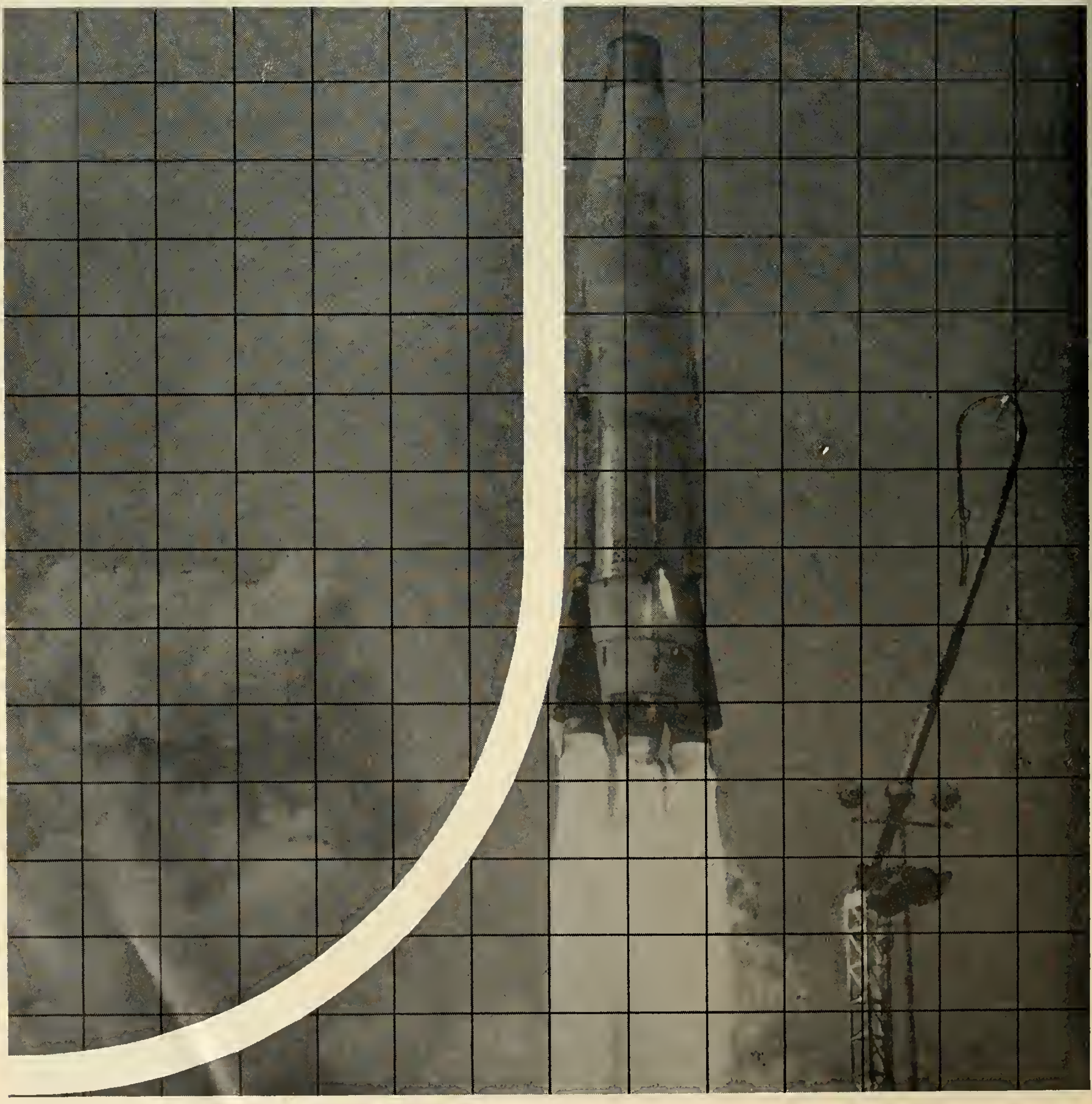

The Countdown

WASHINGTON

Polaris Subs: The Numbers Game

Latest word on the behind-the-door swapping at the Pentagon puts the number of *Polaris* submarines in the final Eisenhower budget at about five. Meantime, the Navy is understood to be preparing a proposal for the new Administration: Put about three more in the FY 1961 supplemental money bill and increase the number in the FY 1962 bill to 12.

Will Minuteman Fly for Christmas?

The first *Minuteman* launching from Cape Canaveral is still scheduled for about Christmastime. The test bird may or may not contain its inertial guidance system. However, whether or not the guidance system flies this time, reports of difficulties with it are definitely understood to be unfounded.

Congress Looks into Space

Congressional plans for a new round of hearings on the nation's space programs are still unsettled because of the changes involved in the arrival of a new Administration and Congress. However, current thinking is that the Senate will take more of a wait-and-observe approach while the House holds earlier hearings. *Mercury* slippage is expected to be a prime target.

Mobile A-ICBM Progress Report

Contractors working on feasibility studies for *FABMIDS*—The Army's proposed mobile antimissile missile—are expected to come up with their answers by about mid-1961. So far, insiders feel that it is still too early to evaluate the concept.

TAC's New Big Punch Coming Soon

The Air Force's tactical aircraft in the very near future will carry two powerful new missiles: The Hughes *GAR-11* and the Martin *GAM-83*. Both the air-to-air *GAR-11* (latest in the *Falcon* family) and the air-to-surface *GAM-83* (the Navy's *Bullpup*) are capable of packing nuclear warheads.

Sen. Symington: How Much Influence?

Among the questions about the Kennedy Administration still to be answered is how much leverage Sen. Stuart Symington will have on defense policies. Symington, who sits on the key Senate Armed Services and Space Committees, is reported to have turned down an offer to become Kennedy's Defense Secretary in order to remain in Congress.

INDUSTRY

Wanted: More Industrial Efficiency

Defense officials are saying both privately and publicly that the Missile/Space Industry must do something about rising costs. They argue the United States could price itself out of business. One recently cited example: While the cost of living in the last decade has increased about 25%, the cost of the *Sergeant* is 400% higher than the *Corporal* which it is replacing.

Recession and Defense Spending

Capital money men feel that any mild business slump in 1961 can only have a buoying effect on defense buying. The Kennedy Administration is already committed to sizeable increases in the defense budget. Any slackening in business conditions is expected by some to result in still further boosts.

Sales and Future Sales

Sperry is understood to have sold the *Sergeant* surface-to-surface tactical missile to the Royal Netherlands Army . . . the Air Force buy for mobile train-based *Minuteman* may hit more than 300 to 400 birds . . . the first big purchases of tactical missiles by Latin America are expected to come in 1961.

Soviet Translating Business Slows to Crawl

The Commerce Department reports that the post-*Sputnik* boom of industry interest in translations of Soviet technical papers and journals is all but dead. Some of the department's Soviet translating services have been dropped and others curtailed.

Air Force-Industry Plan Spaceports

Contractors involved in developing manned spacecraft are to be asked by the Air Force what recovery systems will be needed to convert airfields to spaceports during the next decade. The Air Force study—called Project *Meteor*—will seek to establish as early as possible the standardization of spaceport electronic facilities.

INTERNATIONAL

Red China Seeks To Join IRBM Club

The pinpointing by mountain climbers of a suspected Red Chinese missile test base in Tibet underlines a principal worry of military strategists—the eventual emergence of Red China as a major missile power. The Communist bosses of China are believed to be striving for a buildup of nuclear-tipped IRBM's with which they could hold all of Asia at gunpoint. The question is: When? Some military men speculate 1966 or 1967.

Low-Cost Space for Scandinavians

Norway, Denmark and Sweden are planning a three-year space research program to be conducted by scientists from all three countries. They are expected to use relatively inexpensive rockets launched from portable platforms—possibly balloons. Each country will launch about 75 research rockets primarily to determine electron densities in the ionosphere around the aurora borealis.

Clydeside Remains Unshaken by Red Threats

The stout Scots of Holy Loch for the most part are ignoring repeated Soviet threats that the planned establishment of an advanced floating *Polaris* base in the Clyde Estuary places the area in the bullseye of a Red ICBM. The majority of Holy Loch residents are reported to be fully aware that they already are a prime target. Moreover, the jingle in the Yankees' pockets does warm many a Scot soul.

Building Begins on African Space Tracker

Cement is being poured for the planned 85-foot radio telescope near Krugersdorp in South Africa. Erection of the 100-foot-high antenna is scheduled to begin next month. The big telescope will be used to track American and other space launchings. It will be operated by South African Council for Scientific and Industrial Research. Construction cost: Under $6 million.

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per Paragraph 4.1.1 Procedure 1
From 0.55 to 14.7 p.s.i.a.
per Paragraph 4.5.3 Procedure 3
Under vibration 5-5000 cps
per Paragraph 4.7.1 Procedure 1

for Exposure:

To Humidity and Temperature
per Paragraph 4.4.4 Procedure 1
To Sand and Dust
per Paragraph 4.11.1 Procedure 1
To 50 hour Salt Spray
per Paragraph 4.6 through 4.6.13
To Shock
per Paragraph 4.15.1 Procedure 1
and Paragraph 4.15.2.1
To 10 G's Sustained Acceleration
per Paragraph 4.16.2 Procedure 2

For Linear Motions, Model 500206 provides accuracies of 1 part in 1000 counts.

For Angular Motions, Model 500406 provides accuracies of one tenth degree; Model 500407 provides accuracies of a tenth of a minute.

Each unit provides bidirectional rotation for applications in mechanically geared systems. The Gray BCD coding system is easily translated into other digital format for visual readout or for recording.

IDL

For specifications on these components, ask IDL for their data sheet, "Shaft Position to Digital Converters" or price information, use your letterhead.

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The Missile/Space Week

The Missile Gap Yawns Wider

A British report reminded the Free World this last week of the coming East-West Missile Gap.

The Institute for Strategic Studies says the U.S.S.R. is believed to have 35 ICBM's already on launchers and to be capable of having some 200 by next winter. Moreover, the report said Russia is understood to have six nuclear-powered submarines under construction.

Other reliable sources said all of the nuclear subs in Russian shipyards are believed to be capable of carrying short-range missiles—as are an estimated several dozen Soviet diesel-powered submarines.

The United States at present has approximately a dozen *Atlas* ICBM's operational and 16 *Polaris* missiles aboard the nuclear-powered submarine George Washington. Possibly 60 more American ICBM's will become operational by next winter along with three or four more *Polaris* subs.

McNamara: Harvard to Detroit to the "E" Ring

The majority opinion on the nomination of Ford President Robert McNamara as Defense Secretary is that a driving new force will be taking over the Pentagon's front office in January.

The 44-year-old executive—known in Detroit as one of Ford's "whiz kids"—brings to the Defense Department what is described as incisive administrative ability, acute business sense and a brilliant academic record.

But, most of all, observers noted that McNamara brings a Harvard-trained intellect that takes an imaginative, unfettered approach to the most complex problems.

Dyna-Soar Team Adds Minneapolis-Honeywell

The first R&D program aimed at turning out an inertial guidance system for the nation's first piloted spacecraft—the Air Force's *Dyna-Soar*—got underway this week.

The Air Force tapped Minneapolis-Honeywell to do the job as associate prime contractor. A dozen firms took part in the competition.

The contract covers the first phase of the R&D program. No dollar figures were announced.

M-H said it would center its work on the program at its Aeronautical Division Facility in St. Petersburg, Fla.

New Gains for Pershing, Polaris—and the Cape

Both the Martin *Pershing* and Lockheed *Polaris* programs bolted forward this last week.

The 34-ft solid-propelled *Pershing* roared down the Atlantic Missile Range carrying an inertial guidance system as a passenger for the first time. A fully-guided shot is expected to follow in a matter of weeks.

Meantime, the nuclear-powered submarine Robert E. Lee prepared to begin a series of *Polaris* launchings while submerged off the Florida coast.

But the biggest news at Canaveral involved the Cape itself. The Pentagon released $62 million for a range modernization and expansion program. Much of the money will be used to convert two 11,000-ton ships into seaborne missile tracking stations.

Missile Mystery behind Iron Curtain

The question was asked last week in Washington, in London, in Rome: Is there any truth in the Italian news agency report that a new type of Soviet rocket exploded on Oct. 21, killing about 100 people including three top Soviet missile bosses?

The news agency—Continentale—said the new missile was exploded while being tested in preparation for a "spectacular launching" in November on the anniversary of the Bolshevik Revolution.

Among those reported killed in the blast were Soviet Rocket Marshal M. I. Nedelin, Gen. N. O. Pavlovsky and Prof. D. V. Efremov. Russia had announced their deaths separately.

(See Soviet Affairs column, M/R, Nov. 21, p. 36.)

He took the luck out of heads or tails

This AMF engineer had a delicate problem: to accomplish the separation of the expended stages of a multi-stage rocket. If separation occurs too soon, thrust in the nearly burned out stage may exceed the aerodynamic drag, the tail overtakes the head, and...boom. A million dollar collision and no insurance.

His solution: An acceleration switch that turns the burned out stage loose at the right split second ...a switch that makes rockets think for themselves.

His switch is compact. It is designed to work in any missile at any range with any payload. It is ingeniously simple in conception, design, and operation. A spring is attached to a free swinging hammer, the spring force acting to pull the hammer against the contact plate. At calibration the spring can be set to oppose any G from 1 to 100. When the missile is launched, the hammer is held back by the acceleration forces until the stage decays to the desired separation G. When the spring force overcomes the forces of acceleration, the hammer comes forward, strikes the contact plate, and the circuit required to make separation is closed automatically. No guesswork, no luck, no *collision.*

Single Command Concept

This simple solution to a tricky problem reflects the resourcefulness of AMF people.

AMF people are organized in a *single operational unit* offering a wide range of engineering and production capabilities. Its purpose: To accept assignments at any stage from concept through development, production, and service training... and to complete them faster...in

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AN M/R EXCLUSIVE

20-Year Production Guide Due

- *Manufacturing methods for future outlined*
- *Report to aid industry in long-range planning*
- *29 major vehicle classes systematically studied*
- *No attention given to the 'normal' developments*

by John F. Judge

THE MISSILE/SPACE INDUSTRY will soon be handed an Air Force-sponsored master space guide to expected needs in materials and manufacturing techniques over the next 20 years.

The highly classified guide covering the space production needs of all three military services and NASA has just been completed by a panel of the National Academy of Science's Materials Advisory Board.

It is expected to be circulated on a tightly regulated need-to-know basis. Details of its distribution have yet to be worked out.

The project was initiated by the Manufacturing Methods Division of the Air Force's Air Materiel Command in order to assist in development of manufacturing capability to support long-range advanced weapon system programs. The Department of Defense cooperated with the panel.

The scope of the study includes all aerospace vehicles or weapons systems, except the warheads per se, technically feasible and required in the designated time period.

The three major objectives of the study were:

1. To establish and analyze future mission and system requirements with respect to design criteria, application and environment.
2. Determining and outlining the major areas of materials development and needs based on the above analysis and requirements.
3. Projecting a broad outline covering the major areas requiring manufacturing process development related to the applications and materials requirements identified above.

The study was undertaken by the Aircraft and Astronautics Application Panel in May, 1959, under the chairman, Dr. Elliot L. Katz of Ford Aeronutronic. Warren J. Eding, Staff Aeronautical Engineer, represented the Materials Advisory Board on the Panel.

• **Integrated approach**—The Panel tackled the problem through four subgroups—Communication and Guidance; Propulsion and Auxiliary Power; Structures and Airframes; and Pneumatics, Hydraulics and Launch Complex.

Each subgroup had its own military liaison member and all used the same general methods. The three main objectives were designated Phase I, II and III respectively and each subgroup adhered to this format through their 16 months of operation.

Approximately 10,000 man hours were spent by panel members on preparation of reports in subgroup and panel meetings. The total man-hour figure involving the time spent in collecting and analyzing data could easily increase this conservative figure by a factor of 10. The panel produced a systems analysis of 29 vehicles classes.

• **In the beginning**—Eding says it soon became evident that the outlining of major areas in requiring manufacturing process development made it necessary to progress consecutively from design and applications requirements, through resulting material requirements to the final manufacturing development requirements.

Thus the panel was staffed with personnel from several distinct disciplines and with definite background experience. Technical areas represented included preliminary design, materials evaluation. basic research, fabricating techniques. manufacturing methods development and the military.

Men were selected from 21 different companies active in missiles, aircraft, propulsion, communication, navigation and space systems. Each of these in turn called on persons and sections within his own company for specialized and detailed information.

The common reference point for each of the subgroups is a master vehicle chart which divides the vehicle classes into three major flight regimes—atmospheric, space and combinations. The vehicles listed are a category or type rather than a specific model.

The identification of vehicle categories was dependent upon technical feasibility and prime interest, so that a broad basis of materials and manufacturing requirements could be determined. It was not intended to merely list specifically those vehicles which the Defense Department would build in the designated time period.

Inputs from ARDC, BMD, WADD,

NASA, Army R&D, and BuWEAPS long range planning groups and the preliminary design sections of the represented companies were used to establish the master list. Vehicles thought to be within the state of the art were excluded.

Along with the vehicle classes, a series of parameters such as velocity, mission, life, manned or unmanned etc. were included. These were identified in order to basically describe the vehicle requirements to the design engineer.

Phase I also called for an analysis with respect to induced and imposed environments. Once the problem areas were identified with respect to design and environmental requirements, the next step was to review and evaluate each one in detail. This involved stating the nature of the problem, identifying its components and placing numerical values and ranges on these components. Now the subgroups were ready for Phase II.

• **Building blocks**—The data established in Phase I served as the primary basis for the determination of materials requirements. A "long form" was developed for systematic statement of materials requirements relating to the major components and environments of each vehicle class. Conclusions were extracted from these "long forms" and, since the panel assumed that these results were to be primarily directed to materials experts, arranged accordingly.

For the completion of Phase III, the manufacturing development requirements were ascertained for each specific component of each vehicle, utilizing all of the data from each of the preceding phases.

• **A typical experience**—The operation of Propulsion and Auxiliary Power Subgroup might serve as a brief example of the method employed.

Basing their analysis on the master chart which established the vehicle types in their flight regimes, this group identified a total of nine primary propulsion systems and seven auxiliary power systems. The environmental problem chart prepared from this data permitted the subgroup to specifically define each problem, its parameters of importance and common requirements.

A materials description form was prepared for each of the application problem areas. Then Phase II in propulsion was completed with the identification of materials requirements in 11 basic materials descriptions. The final phase entailed an analysis of all of the accumulated data and the identifying of manufacturing requirements in nine established categories.

These categories aided in the formulation of manufacturing conclusions. The list covered such concepts as materials forming processes, joining and mechanical fastening, material treatment, electrical and electronic component fabricating techniques and others of a similar nature.

• **Cannibalizing**—The flexibility of the panel as it progressed can best be illustrated by the fate of one subgroup—Hydraulics, Pneumatics and Launch Complex. This subgroup defined the systems within the launch complex and vehicle support systems which were required for the vehicle types under consideration. While the major problems were identified as they emerged, the subgroup found it impossible to assign quantitative environmental parameters.

Since this data was not definable enough to ultimately call out required materials characteristics, the subgroup foundered. The principal reason was that the environmental parameters are so closely related to detailed vehicle design configurations that it was not feasible to predict worthwhile requirements without these design descriptions.

The subgroup was disbanded and absorbed by the other subgroups as was their first and second phase reports. Thus an apparent loss was turned into a net gain because each of the other subgroups used the personnel and reports where applicable.

The Communications and Guidance Subgroup identified their materials and process requirements in categories of electronics. magnetics, mechanical requirements, radomes and antennae. Eding states that this section of the report " . . . adds a refreshing and most important contribution to the analysis of materials requirements by pointing out the non-structural application requirements."

• **Normal progress excluded**—The report does not offer solutions to the major manufacturing problems—it only identifies them. In addition, the panel members restricted their efforts to those requirements which they felt would need an additional effort and emphasis beyond the state of the art. Hence the report does not outline all materials research and development or manufacturing development needs.

In Eding's words—"It is not intended to be a detailed road map which will substitute for thinking. It is a strong skeleton built from a great deal of effort and depth of experience . . ." but the flesh will be added by the user.

The report will be released to those who establish proper clearance and need-to-know through the Air Force, ASTIA and other agencies authorized to handle these documents. ⌘

Turn to page 32 for a complete list of the membership of the Panel.

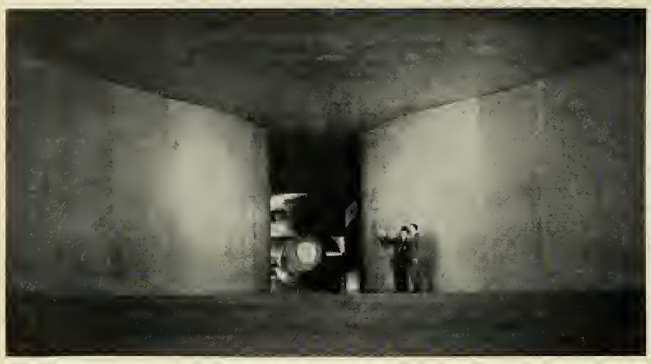
Solid Propulsion Subgroup —A Typical Problem Chart

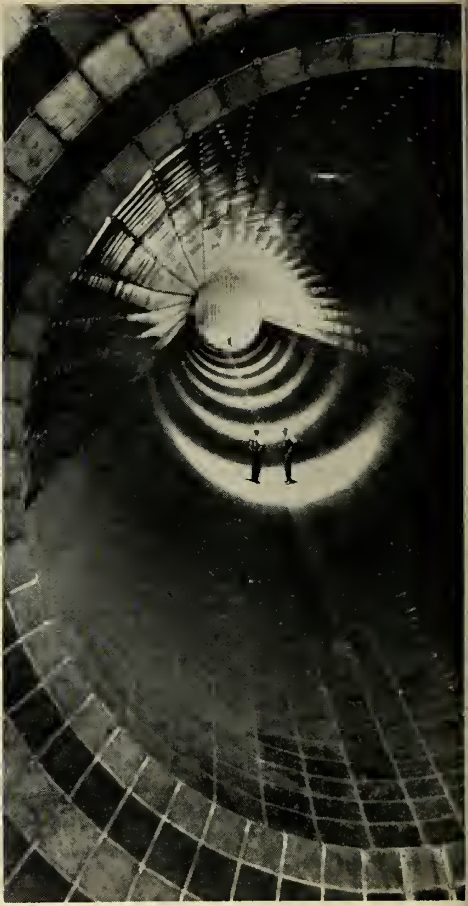
			Thermal	Chemical	Radiation	Loading	Duration	Atmosphere
Atmosphere	Subsonic							
	Supersonic							
	Hypersonic							
	Booster	●	S	P	O	S	P	O
Space	Orbital							
	Interplanetary		S	P	P	S	P	O
	Space Platform							
Combinations	Boost Glide	●	S	P	O	S	P	O
	Orbital & Return		S	P	O	S	P	O
	Interplanetary & Return		S	P	O	S	P	O

[O] No Problem [P] Problems [S] Serious Problems
● Application

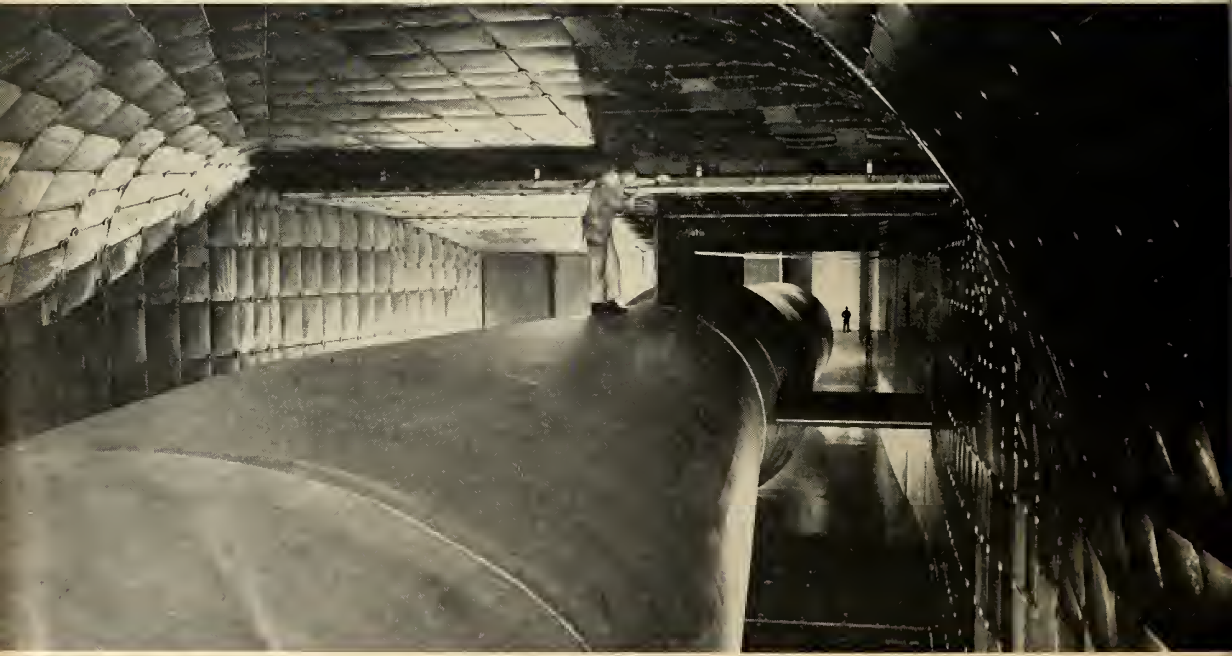
Test Tunnel Readied

Mach 5 Flight in Near-Vacuum





THE NEW SUPERSONIC Propulsion Wind Tunnel at the Air Force's Arnold Engineering Center, Tullahoma, Tenn., will soon be able to test rocket engines at speeds up to Mach 5 and at simulated altitudes up to about 200,000 ft. The supersonic nozzle (above) has flexible steel sidewalls to regulate the velocity of the airflow. The supersonic circuit (right) is 27 feet wide. The test section is 16 x 16 x 40 ft. The great scavenging scoop (below) removes exhaust gases from the airstream during a test. The tunnel is expected to save millions of dollars by performing preflight testing which was previously impossible. ⁂



NASA Lacks Funds Now For Next Lunar Orbit Shot

Planning calls for putting Ranger III into lunar trajectory in 1962

REGARDLESS OF the success or failure of last week's scheduled *Atlas-Able* moon shot, there will be no followup for more than a year. There is no money.

On Wednesday morning, the *Atlas-Able* came within seven minutes of launch at Cape Canaveral, but was postponed when a difficulty developed in the autopilot. This was corrected immediately, but then a special technician was flown in from Convair-San Diego to do a small welding job. At M/R's press time, the launching was still pending.

Under current funding and development plans of the National Aeronautics and Space Administration, the next attempt at a lunar trajectory will be made by the third *Ranger,* early in 1962.

Flight tests of the *Ranger* spacecraft, boosted by *Atlas-Agena B* vehicles, are scheduled to begin in the third quarter of 1961. However, the first two *Rangers* will be deep space probes. *Ranger III* will be the first to carry the lunar rough landing capsule and a retrorocket to slow its descent.

Edgar M. Cortright, head of NASA's lunar and planetary programs, said *Ranger I* will be launched into a highly elliptical earth orbit with apogee of more than 100,000 miles. The distance is not known more exactly because there is still some uncertainty about the exact *Agena B* performance, he explained.

The trajectory for *Ranger II,* whose launch date target is in the fourth quarter of 1961, has not yet been established. Cortright said there is a possibility it will go near the moon but no attempt will be made at a lunar orbit, such as in the *Atlas-Able* program.

• **Progress cited**—Cortright declared in an interview that he is satisfied with the NASA lunar program because of its steady progression from the *Atlas-Able* shots to the five *Rangers* and then to the *Centaur*-launched *Surveyor* soft-landing spacecraft, beginning in 1963.

There is no consideration of adding to the lunar orbit program in progress, he said, adding that he is satisfied with the internal balance of apportionment of resources among the various NASA programs.

In response to a question whether it is possible to add an *Atlas-Able* to the program, if the administration should direct it, Cortright said yes—at a cost of about $10 million per launch.

Cortright did comment that, if such a shot were ordered, an *Able* need not be used as the second stage. He noted that *Delta* stages are now being delivered for NASA vehicles. Although he did not say so, one can assume that the *Delta*'s guidance would be of great value in achieving the accuracy needed for a moon shot.

• **Guidance untested**—The *Atlas-Able* mission has been to place a 388 lb. paddlewheeled sphere into a 5000-mile lunar orbit. Objectives are to make a more thorough investigation of the space environment near the moon and to develop a technology for controlling and maneuvering a spacecraft at the lunar distance of a quarter million miles.

However, in the first three attempts, one *Atlas* exploded on the pad in a preflight test and two launch vehicles failed during powered flight. The terminal guidance technique, using a hydrazine engine commanded from the earth, had never been tested in flight.

The first two *Rangers* will carry a series of seven experiments to investigate electromagnetic and particle radiation and measure micrometeorites, similar to experiments aboard the *Atlas-Ables.*

However, the later *Rangers* will have television cameras and gamma ray spectrometers for the flight phase and a single-axis seismometer protected by crushable material for the rough-landing package. Many materials, from honeycomb to balso wood, are being considered for the spacecraft protection.

The seismometer will be locked during flight. A fluid lock will open either on impact or on a time basis. The seismometer will be capable of detecting moonquakes and the impact of meteorites.

• The five *Ranger* flights are to take place in a period of about a year beginning in the third quarter of 1961. Meanwhile, NASA is preparing to select a contractor to develop the *Surveyor,* which will make a true soft landing on the moon.

Four contractors—Space Technology Laboratories, McDonnell Aircraft, North American's Missile Division and Hughes Aircraft—completed five-month competitive studies last week. Cortright said he expects to choose a prime contractor from among them early in 1961. Flight tests of *Surveyor,* boosted by a *Centaur* vehicle, are to begin in 1963.

Discoverer XVIII

AF Studies Specimens For Shielding Date

THE AIR FORCE is analyzing biological specimens recovered from *Discoverer XVIII* with hope that they will bear out the favorable shielding data indicated in *Discoverer XVII.*

The latest *Discoverer* capsule carrying human bone marrow, eyelid tissue, gamma globulin and cancer cells was recovered Dec. 10, after 48 orbits in three days. Jubilant Ballistic Missile Division officials termed the shot "most successful" in the *Discoverer* series because of the precision of the recovery operation.

The extended trip was made possible by the use of an improved *Thor-Agena B* which had 15,000 lbs. more thrust than *Thors* used in other shots. The booster was streamlined by eliminating the unnecessary guidance compartment.

The *Agena B* carried for the first time an inertial reference package developed by Minneapolis-Honeywell's Aeronautical Division. The one-foot-diameter package contained three gyroscopes which sensed satellite deviation and signalled the control system. It prevented tumbling and maintained planned satellite orientation to earth.

Reentry was triggered by ground command overriding a preset timer in the vehicle.

Results of the previous shot, *Discoverer* XVII launched Nov. 12, have indicated that biological specimens including man may be able to withstand heavy solar flares with a minimum of shielding.

Some seven hours before launch a massive solar flare began which continued for the first 13 hours of the satellite's orbit. Dr. George W. Crawford, nuclear physicist at the School of Aviation Medicine disclosed that the specimens received up to 30-35 RAD during the 50 hours they were in space.

He reported that radiation dosimeters indicated that the specimens had not received a lethal dose. Previous estimates of the radiation level of such flares put the dose at intensities as to kill living specimens unless they were protected by heavy shielding.

The experiment also indicated that aluminum might be a more effective shielding material than lead. Dr. Crawford reported that some specimens were encased in different types of metals to test their shielding properties. Some were shielded only by the thin aluminum covering of the specimen capsule and the recovery vehicle. These specimens apparently fared better than those protected by lead shielding. ⌘

Tory II-A tests near . . .

Will Pluto Provide Power for SLAM?

by Frank G. McGuire

JACKASS FLATS, NEV.—Tests of the Tory II-A reactor for the Pluto nuclear ramjet program slated for next month may prove the feasibility of the concept as a powerplant—possibly for the Air Force supersonic low altitude missile—*SLAM*.

Coincident with the announcement of the beginning of tests, the Atomic Energy Commission and the Air Force released major design and operating details of the prototype reactor test unit here.

Brig. Gen. Irving Branch, charged with development of the reactors for the program, said the Tory II-A has "strained the state-of-the-art in reactor technology." He said design of the fuel elements posed some difficulties during hardware design, but he expects future problems to mainly involve testing methods. Testing is now limited to a maximum of 90 seconds by available air supply in the tank farm adjacent to the test bunker.

"How do you adequately test something like this . . . designed for operation at Mach 3 for several days?" Branch asked. "Our present test procedure requires the air to be heated to over 1000°F before introduction into the reactor. At the rate of 720 lbs. of air per second at 360 psia, it's going to be tough."

The Air Force has set no target date for a flying nuclear ramjet; under the current pace, one could materialize about 1965. How close this would be to the proposed *SLAM* configuration, no one has said.

Branch strongly emphasized that there is no established military requirement for the Pluto program.

Nevertheless, Pluto seems to be the most likely, and perhaps the only, program capable of turning out a powerplant for the *SLAM*, and it will very likely be a descendant of Tory II-A which eventually powers the supersonic low altitude missile.

When a military requirement is established, funding for the program will probably be increased, but the present rate of funding is expected to continue for the next several years. Funds for the next fiscal year will reportedly run around $25 to $30 million, with AF providing about 25% of the total. To date, funding has amounted to $63,400,000 since 1956, not all at the same annual rate. Of this, AF has put up $17.4 million, and AEC the remainder.

The Air Force said there is close coordination between the Pluto program and the aircraft nuclear propulsion (ANP) program developing a nuclear turbojet. Following the Tory II-A program will be the Tory C series of reactors, closer to flight-type hardware and having a control system which will approximate that to be found in airborne vehicles.

(Except for identifying Coors Porcelain Co. as fabricator of the fuel elements, AEC/USAF have revealed little about the Tory C series. The air supply at the test site will be modified to allow for longer test times.)

Lawrence Radiation Laboratory of the University of California at Livermore, Calif., is under contract to AEC to determine the feasibility of the nuclear ramjet, and is responsible for the overall Pluto program. It fills the same role as Los Alamos Scientific Laboratory does on the *Rover* nuclear rocket program, although there is no similarity in the reactors used.

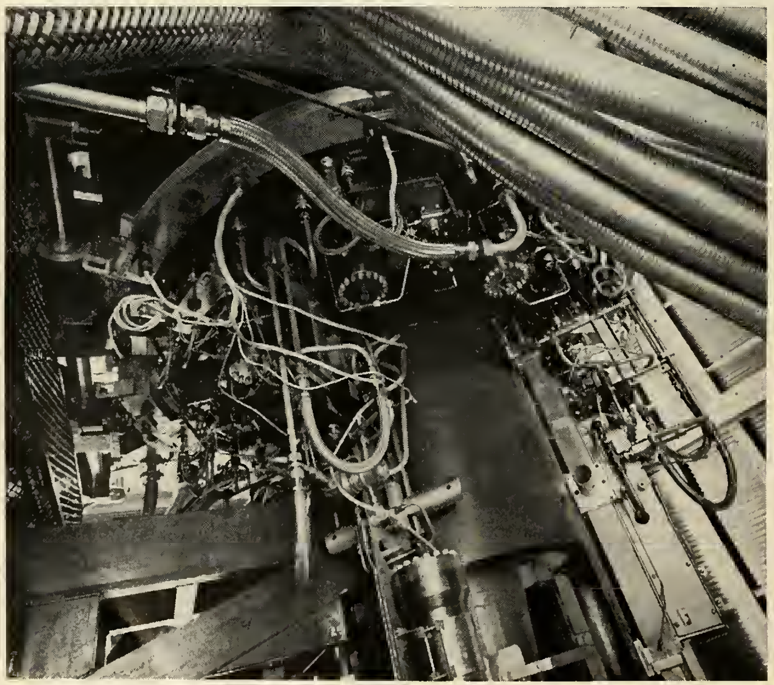
- **Tory II-A design**—Two reactors presently make up the Tory II-A "family"—Tory II-A-1 and Tory II-A-2. The former is the result of early R&D work at LRL, and it is this reactor which will be tested next month. AEC has one reactor core and two test units for this model. The core can be used in either. Fuel elements were produced by General Electric's Aircraft Nuclear Propulsion Department.

Tory II-A-2 is a backup system and is similar except for fuel element design. The fuel elements are being fabricated by Atomics International Division of North American Aviation.

Tory II-A-1 is a direct-cycle, air-cooled reactor fueled with highly enriched uranium homogeneously mixed with beryllium oxide. Total design power of the core is 150 thermal megawatts.

Prime objective of the initial tests is to determine reactor operation under supersonic aerodynamic conditions, with anticipated high shock, force and g loadings. Objectives for the overall program also include the study of struc-

(Continued on Page 35)



VIEW OF TORY II-A reactor in test facility shows control vanes. Allowing neutrons to escape through the vanes reduces the power level as desired.

1961

Key Phase In Race For Space Lead

Soviets and U.S. to try manned shots; Titan due to become operational; new Administration will hike funding; prospects for propulsion, materials, electronics, GSE

by Jay Holmes

1961 WILL BE THE YEAR of the Astronaut.

The race for space will enter a major new phase with attempted manned launchings by both Russia and the U.S.

So far as is known, Russia's manned space exploration efforts will be a continuation of her experiments with the 10,000-lb. *Sputnik* space ship. Every indication is that, when the spacecraft passes developmental tests, it will be used to carry one or two men on an orbital mission.

America's program revolves around Project *Mercury*, a one-ton capsule designed to carry one man in orbit with an *Atlas* booster. But prior to the *Atlas* orbital flights will be a series of 200-mile ballistic training flights of the capsule with use of a Redstone booster.

- **Chance to beat Russia**—Manned *Redstone* flights probably will begin in March or April. Since *Sputnik VI* burned up on an attempted re-entry with its dogs and other living passengers Dec. 2, it seems safe to assume that the next *Sputnik* will not carry a man. And, since the Soviet *Sputnik* space ship tests have been at three-month intervals, it also seems safe to guess that Russia will not achieve manned orbital flight before April or May at the earliest.

Thus there seems a chance that one of America's astronauts may make the short hop before Russia puts a man or men in orbit—thus gaining at least a technical first by lifting him to an altitude of 125 miles, above everyone's definition of the threshold of space.

But the first manned U.S. orbital shots cannot take place until late in the year, and indeed may well slip into 1962. Thus it still seems almost certain that Russia will win the race for manned orbital flight.

In unmanned space exploration, 1961 will see the first flight tests of the *Ranger*, a spacecraft designed for rough lunar landings of a moonquake seismometer. Two deep space probes with the *Ranger*—launched by an *Atlas-Agena B*—are programed for 1962 in preparation for lunar landings in 1962.

Altogether, NASA will fire about a dozen satellites and five to eight deep space probes during the year, in addition to test and training shots in the *Mercury* program.

- **Adding ICBM's**—On the military side, *Titan* can be expected to join *Atlas* as an operational U.S. ICBM, and the first major increments will take place in America's ICBM forces—now consisting of a scant dozen *Atlases* at Vandenberg and Warren Air Force bases.

The Air Force will try for its first successful *Samos* reconnaissance satellite and *Midas* early-warning satellite launchings.

In civilian applications, NASA can be expected to launch its first active communications satellite—a prototype of the eventual commercial satellite. The Federal Communications Commission will authorize one or more private companies to use portions of the radio spectrum on a temporary basis for similar experiments—although the industry launchings probably will not take place before 1962.

In the space sciences, major efforts will be made with satellites, deep space probes and sounding rockets to map the danger zones of the Van Allen belts and to assess the danger to manned flight from solar flares.

Industry will encounter tighter competition as airframe companies, facing continued downtrend in aircraft, expand their capabilities in the missile/space field.

On the international scene, a third country will enter the satellite field with a U.S. launching of a *Scout* satellite with British instrumentation aboard.

- **Boosting propulsion**—America expects to make major strides in the race to develop bigger propulsion systems during 1961. The year will see the first flight of the *Saturn* booster, with dummy upper stages. A radical change in upper stage propulsion will be tested with the first flight of the *Centaur*, a liquid hydrogen-burning upper stage atop an *Atlas*. The *Centaur* flight will be America's first attempt to put a satellite into a 24-hour orbit.

The *Agena B* restartable upper stage, first tested in late 1960, will be used on missions with both *Thor* and *Atlas* boosters. The all-solid *Scout* satellite launcher will complete flight tests.

In materials, 1961 will be a year of production, particularly of missiles. If the degree of effort involved is any criterion, such pressing problems as those associated with reinforced plastic cases will be solved.

In electronics, probably the year's major effort will be aimed at component reliability, as systems become bigger and more complex.

GSE facilities due to go into operation in 1961 include the *Saturn* and *Centaur* complexes at Cape Canaveral, the *Scout-Little Joe* blockhouse at Wallops Island, a new test cell for the *Rover* nuclear rocket at Mercury, Nev., and several new installations for the Pacific Missile Range.

- **Where money may grow**—With a new administration taking office Jan. 20, moves will be made to increase the current rate of missile/space activity. The final Eisenhower budget is expected to include $41 billion for defense and a little over $1 billion for the National Aeronautics and Space Administration. The big question is how much the new Kennedy Administration will modify it with a supplemental budget or suggested amendments in testimony before the congressional committees.

The most likely final figure for defense is in the neighborhood of $43 to $44 billion. A big space item increased may be *Dyna-Soar*, if the new administration supports its Air Force proponents. The Army will continue its drive for production of *Nike-Zeus*, while the Navy presses hard for seaborne launch facilities.

In the civilian space program, the biggest single program increase may

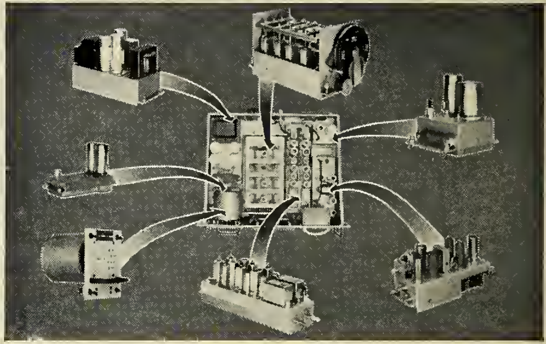
(Continued on page 34)

For more than a quarter century, Hallicrafters has worked in close partnership with our armed forces on fast solutions to critical military electronics problems. Out of this priceless experience are emerging startling new ideas and hard-hitting, fast-moving techniques to keep our country one jump ahead in electronic warfare . . .

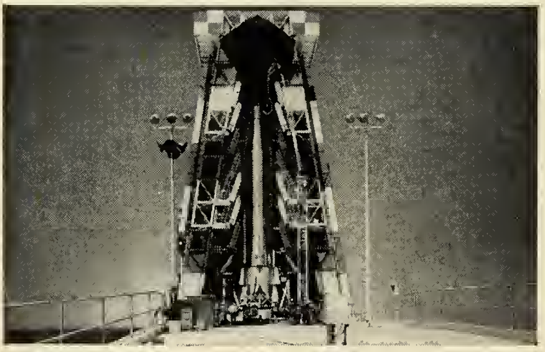
B-52 and other military aircraft will be protected by the most potent Electronic Countermeasures equipments yet devised. These equipments were developed in close teamwork with the Air Force under Hallicrafters' QRC (Quick Reaction Capability) program. Now qualified to meet full environmental specifications, they are in quantity production.

h
hallicrafters
World Wide "Blue Streak" Project

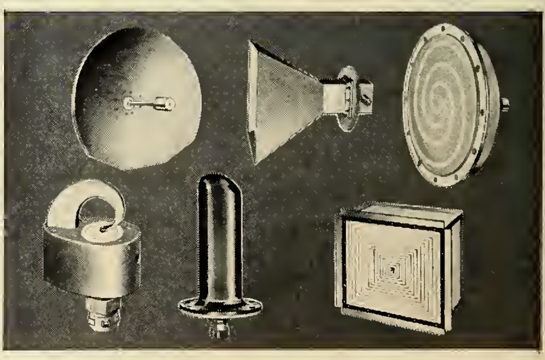
New levels of speed and efficiency are being reached in equipment modernization, retrofit and technical support programs with Hallicrafters' radical new "Blue Streak" project. Specially-trained Maintenance and Technical Support Teams, close-knit and flexible, can be tactically deployed to accomplish maintenance, installation and testing of electronics weapons systems anywhere in the world.



Hallicrafters communications leadership is exemplified by new high frequency Single Sideband receiver, (model no. SX-116). 100% modular design permits simple modification for compatability with existing and future communications systems. Stability, with proper available plug-ins, is better than one part in 10,000,000 per month. Hallicrafters also offers an existing capability in receiving and transmitting techniques up to frequencies of 50,000 megacycles.



Hallicrafters participation in the Atlas missile project helped to develop capability for many areas of the complex missile field, including code translator data systems; ground support equipment; ECM testing and antenna systems. Current explorations involve latest Infra Red techniques.



Airborne antennas and micro-wave components with power capability in excess of 1,000 watts, can be made available to solve tomorrow's very high power handling requirements. Testing of microwave components is possible with special high power generators, designed and built by Hallicrafters.

Looking for a challenging new opportunity? We are interested in qualified engineers at all levels. For full details in confidence, contact William F. Frankart, Director of Engineering.

For further information on Hallicrafters facilities and experience in military electronics research, development and production, please write to:

hallicrafters h company

Military Electronics Division,
Chicago 24, Illinois

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Technical Countdown

ELECTRONICS

Piano Tuned Radar for Boston

A low-cost radar antenna will be constructed for the Air Force by North American Aviation's Columbus Division at Tyngsboro, Mass. Tension rods will connect the five concentric rings forming the reflector's backup structure. Proper tension on the rods will be measured sonically.

Navy Gets 3D Radar

Hughes Aircraft's Frescan, a single-antenna radar system capable of pinpointing simultaneously a target's range, bearing and altitude are standard equipment on *Talos, Terrier* and *Tartar* armed ships. Range and height information is obtained by electronic scanning in a vertical plane in milliseconds while rapid rotation of the antenna supplies target bearing.

Missile Reliability Formula Standardized

Vitro Laboratories is establishing a yardstick for predicting how often a missile system will fail to perform acceptably under specified conditions from launch to target and detonation of the warhead. The study is being supported by a Navy BuWEAPS contract.

Satellite Warranty Proposed

Reliability requirements of communications satellites demand establishment of a new parameter, says NASA's Leonard Jaffe. Mean time to failure must be replaced by the concept of guaranteed lifetime.

Short Circuitless Relay Developed

Mathematicians at Moscow State University have reportedly completely synthesized a contact relay circuit which is not disrupted by any short circuit. It's claimed that the circuit uses no duplication of components to achieve the immunity.

PROPULSION

MGD Thrust Measured Directly

Continuous thrust levels on the order of two pounds have been measured directly by Northrop engineers on their magnetogasdynamics engine. The engine uses a three degrees-of-freedom thrust balance and strain gages in the measurement, which is believed to be the first of its kind.

Solids Ignited Hypergolically

United Technology Corp. reports successful tests of hypergolic ignition of solid-propellant motors—by spraying with a small quantity of chlorine trifluoride. Tests succeeded with both PBAA and polyurethane motors, UTC says.

Reverse-Flow Nozzle Display Reversed

Rocketdyne's plans to show its reverse-flow nozzle at the ARS convention were okayed by the Air Force—but classified secret by the Department of Defense.

MATERIALS

Largest Columbium Ingot Forged

Wyman-Gordan pressed out a closed-die forging from a 1300-lb. ingot of electron beam-melted columbium producing the world's largest forged piece of the refractory metal.

Ideal Fuel Cell Fuel Lacking

Hydrogen appears to be the best available fuel for fuel cells but it and other known fuels fall short of the ideal. Union Carbide scientists expect new developments in cryogenics to offset the high cost of using hydrogen.

X-15 Nose Blunted

Northrop Corp's new "hot nose" will be flight-tested on the *X-15* in the near future. The rounded profile is expected to aid the rocket ship's pilot in determining the attitude angles that minimize frictional heat during the critical exit and entry phases of hypersonic flight in the upper atmosphere.

Russian Pressure Soars

Pressures of five million atmospheres have been reported by Soviet scientists, who say they achieved the level for a fraction of a second through use of an explosion principle. The Russian researchers also are constructing a device for producing hydrostatic pressures of one million atmospheres at the USSR Academy of Sciences.

New Space Chamber at G.E.

General Electric's 50-ft. vacuum chamber is now under construction. Designed for testing satellite payloads, the chamber will pump down to 10^{-6} to 10^{-7} mm Hg and will have a simulated sun, radiating all of the solar spectrum during quiet periods.

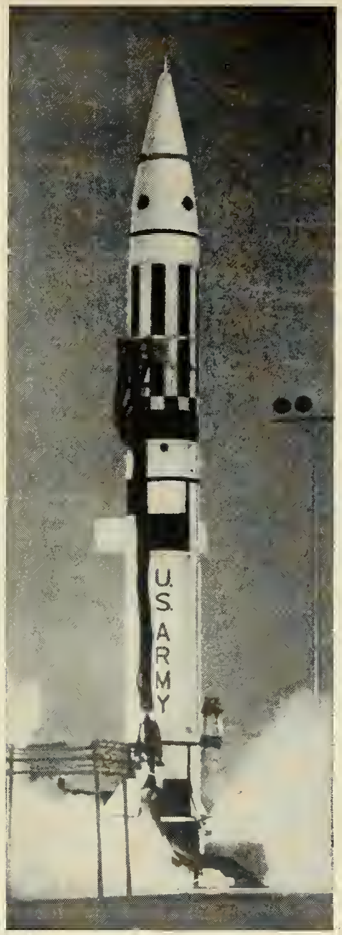
SUPPORT EQUIPMENT

PMR's All-Weather Facility Operational

Two systems, Cubic Corp's COTAR and Gilfillan radar, are in operation at Point Arguello, providing launch ability under extreme overcast conditions. Previously, seasonal fog had sometimes prevented optical tracking instruments from "seeing" the vehicle at launch to insure safety to persons and property in the immediate post-launch phases. End results of the systems are the same—although COTAR is passive while the Gilfillan radar "skin tracks" the vehicles.

Russians Control Plant Growth

Electronic control of the growth of "Chlorella", a water plant of interest to Soviet scientists for space flight, is being tested in the USSR. The rate of growth of the plant can be controlled by a regulator whose operation is based on the attentuation of a beam of light which passes through the plant and reaches a photocell. The latter, as a sensor, reacts to changes in the concentration of live cells. The regulator maintains optimum conditions with respect to illumination, content of mineral agents and percentage of carbonic acid in the water.



KEARFOTT developed

and now produces

hydraulic control systems

for the Pershing missile.

***Engineers:** Kearfott offers challenging opportunities in advanced component and system development.*

KEARFOTT DIVISION
Little Falls, New Jersey

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Ultrasonics Improves Fuel Loading

Principles of sonar applied to boost fueling accuracy; Titans and Saturn booster first to employ new method developed by Bogue.

by John A. Herbst
and
Edward P. Schinman
Bogue Electric Mfg. Co.

A MAJOR IMPROVEMENT in the accuracy of liquid-propellant loading of rocket motors is offered by the new technique of ultrasonic gaging.

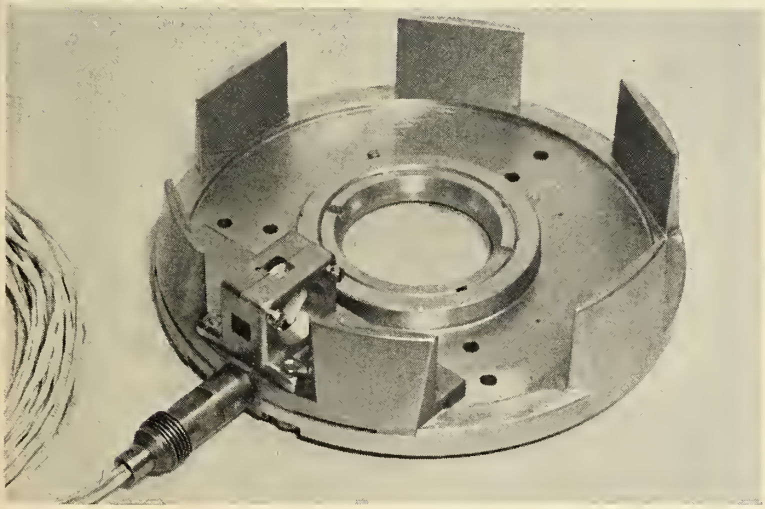
Developed by Bogue Electric Mfg. Co., the ultrasonic system—using the principles of radar and sonar—is reported to be simple, reliable and low in cost. It provides a rapid-response control device for fast automatic loading, as well as an instantaneous visual readout for monitoring.

The result of 10 years of research and development, one Bogue system is being used for automatic loading of the *Titan* ICBM. Another is being built to handle UDMH and nitric acid loading for the *Saturn*.

One principal advantage of the system is its precision. Accuracies of better than 0.1% have been achieved in total weight loading of cryogenic and other missile fuels.

Another advantage is simplicity, particularly of the transducer used in the tank. Simplicity is particularly important in the gaging of highly corrosive fluids, since simple parts can readily be made to resist or be protected against corrosive action.

The transducer is small and light—two obvious advantages in missile applications.



TRANSDUCER, located in bottom of fuel and oxidizer tanks, is simple and small (6x2 in.). Unit is all that is required in missile itself for ultrasonic system.

• **Similar to sonar**—The basic principle of ultrasonic gaging is similar to sonar, or radar. A pulse of energy, transmitted by a transducer in the bottom of the tank, travels until it reaches the surface of the liquid. Here, a portion of the energy is reflected and returns to the transducer. The elapsed time between transmission and return indicates the height of the liquid.

In a simple ultrasonic gaging system, the basic components are a transducer, a receiver-computer, and an indicator.

In operation, a repetitive pulse of predetermined width and amplitude is coupled to the transducer element, which produces a sonic pulse. This pulse is transmitted into the liquid, where it travels to the junction between the liquid and the air or vapor above and is reflected and returned to the transducer in the form of a sonic echo.

(Continued next page)

The Dividends from Accurate Loading . . .

ACCURACY IN FUEL LOADING can be critical. As an example, consider the case of a missile requiring a minimum of 100,000 lbs. of propellant to reach its target.

Loading this amount to a 1% accuracy would mean that the actual amount was between 99,000 and 101,000 lbs. Consequently, the load command would have to be increased to 101,000 lbs. to assure the minimum. However, this means that the actual weight loaded would be between 100,000 and 102,000 lbs. The propulsion system is therefore penalized: it must be capable of accelerating an additional 2000 lbs. which might be on board.

Increasing the loading accuracy to 0.1% would reduce this 2000-lb. figure to 200 lbs. The 1800 lbs. saved could be used for additional range, additional pay load, more reliable guidance and controls, etc.—or the size of the missile required for a given mission could be greatly reduced.

Loading by level alone is not sufficiently accurate, particularly in the case of cryogenics. Liquid oxygen changes its density by approximately ½% per degree Kelvin. Consequently, in the example given, if loading were done by level, such as by point sensors, a penalty of 1000 lbs. would result even if the average temperature of the liquid oxygen throughout the tank were known to within a total accuracy of one degree (or plus or minus ½ degree). ::

(Continued from page 21)

The transducer then converts the sonic echo into an electrical signal.

The time between transmit and the first echo is converted into level information for readout or control functions. The conversion is made by the computer, which compares the elapsed time with the velocity of sound through the liquid.

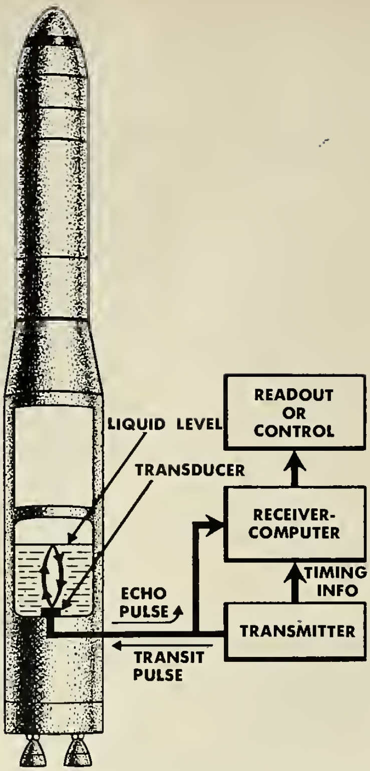
Obviously, the accuracy of the measurement depends not only on the accuracy of the echo time measurement, but on the velocity information. The latter is obtained by continuously sampling the propagation time over a precisely known distance. This is accomplished by a second, or "calibrate" transducer with a precisely fixed reflector mounted in the same unit as the measure transducer. Thus, continuous velocity information is available to the computer; levels can be accurately measured without presetting precise velocity information into the computer.

- **Corrected for density**—The liquid level can thus be precisely gaged and controlled. However, in loading a missile, the weight rather than the level should be the governing factor, since total weight determines the total propelling energy available.

The computer in the system calculates liquid volume on the basis of height and cross-sectional area. The cross-sectional area, a known factor determined by the geometry of the tank, is programed into the computer and multiplied by the instantaneous height of the liquid. The volume quantity obtained is multiplied by the specific density to obtain total weight.

The velocity of sound through a particular liquid varies with its density. Thus, if the computer is programed with a known velocity corresponding to a known density, any change in density can be detected. The computer compares the velocity as measured by the calibrate transducer with the programed standard and, in effect, multiplies the volume by the resultant to obtain the instantaneous weight. These measurements and calculations are performed many times a second, providing virtually continuous information for readout and control.

- **Better accuracy attainable**—Since measurements may be made with accuracy within a fraction of a millionth of a second, a system can be designed to any accuracy desired. Ultrasonic systems presently in production integrate temperature and density variations, allow for variations in tank construction, and provide for measurements within a few inches of the bottom and up to the top of the tank with an overall accuracy of better than 0.1% by weight. This system is fully automatic and provides for rapid automatic loading of multistage missiles.



ULTRASONIC gaging system measures liquid level in missile tanks by same principle as sonar. Time required for the transducer signal to travel to the surface and return is measured and computed to yield actual volume (and weight) of the propellant loaded.

While guaranteed accuracies of 0.1% by weight of liquid oxygen is expected of the Bogue system, measurements indicate that it can provide accuracies as close as 0.05%.

The system can also be used to accurately indicate the temperature of the liquid being measured.

Since the ultrasonic system is insensitive to pressure variations and not affected by acceleration, it can also be successfully used for inflight measurements.

The system offers further advantages. Each stage of a multistage missile can be individually gaged and loaded simultaneously. Also, the errors caused by condensation on the exterior surface are eliminated. Repeatability and, therefore, absolute control is attained.

The Bogue ultrasonic system being used for automatic loading of the *Titan* allows for rapid filling up to a selected point, then slow filling up to slightly more than the desired weight. This "overfill" condition is maintained by a proportional control signal which controls a valve to admit LOX as required to replace the boil-off loss.

Shortly before launch, a signal is given which bleeds down the tank to the exact weight desired. An alarm circuit is activated if the level falls below 99.9% of the desired weight. Another circuit indicates the satisfactory functioning of entire system. The system also provides voltages for indicating and recording the instantaneous percentage of the desired weight in the tank. ¤

Commercial Satellite Developed by Hughes

AN EXTREMELY SMALL and lightweight commercial communications satellite with life expectancy of over one year and several hundred channels has been developed and built by Hughes Aircraft Co. The cake-shaped payload will use 2700 solar cells mounted on its sides as power supply, and will handle both telephone and television communications.

The payload is reportedly in such an advanced stage that flights tests may begin next year, with the first launch testing telephone linkage and the next one checking television capabilities. Sources indicate that cooperation from the government or another interested company would be necessary before flight testing begins.

- **Cake-like**—Still lacking an official designation, the payload is referred to by some Hughes officials as *"ComSat"* and was developed entirely with company funds. The firm is reluctant to discuss details of *ComSat*, but it emphasizes that it has already built one complete unit.

ComSat is a cake-shaped device, 29 inches in diameter and weighing 32 lbs. It is an immediate-relay device with no storage features. Solar cells will be mounted on the sides only, leaving the flat surfaces free for electronic sensors and antennas.

The payload will go into orbit with the solar cells facing the earth. Nitrogen gas jets will flip it into an attitude where the antenna-equipped flat side is facing earth. Then nitrogen gas jet will impart a spinning motion to stabilize the payload in this position.

Hughes declined to comment on the number of transmitters, transmitter power, estimated costs, the dollar-break-even point in commercial use, or other details.

The company said it has offered the payload to the National Aeronautics and Space Administration, the Army and commercial users. It would not specify which commercial users were approached. ¤

NBS Puts Infrasonic Waves to Work

by William Beller

A NEW WINDOW facing the upper atmosphere is now being opened for students of geophysics. It is the far low end of the frequency spectrum, in the inaudible sound or infrasonic band—below 15 cycles per second.

Many events occurring in the upper atmosphere have ripples in the infrasonic band. Among these are explosions, earthquakes, tornadoes, waves set up by the sun's effect on the earth's magnetic field, and a mysterious set of very low pressure waves that might be gravitational waves resulting from the shifting of atmospheric layers of varying temperatures and wind speeds.

For what is believed to be the first time, the National Bureau of Standards has quantitatively studied the relation between the sources of infrasonic waves generated in the atmosphere and the incident sound pressure, the direction of approach of the incident wave, and the speed of the wave across the earth's surface.

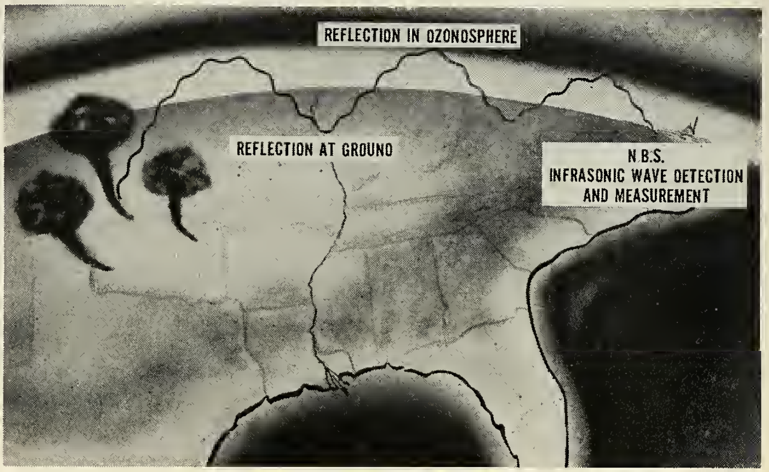
- **The shadow zone**—About the time of World War I, an odd and by now well-known anomaly was observed: the sound of cannon fire was heard within a radius of 100 kilometers of its source, then skipped about 100 kilometers before it was heard again.

The effect was caused by reflection of sound waves from an upper atmospheric layer in which the speed of sound was greater than at sea level. It was easily deduced that the layer's temperature was higher than the temperature of the air at ground level.

Having gone this far, observers began building a temperature structure of the atmosphere. They based it on the skip distances of the sound and the transit times from source to observer. The lowest audible frequencies from the source were monitored because they were the least attenuated.

The limiting condition is reached in infrasonics; here, the waves can be propagated for great distances. This stems from the fact that the fraction of sound energy absorbed per unit distance of propagation is roughly proportional to the square of the frequency.

The temperatures derived from the early work were most recently confirmed by direct observations by instrumented rockets of the upper atmosphere.



ARTIST'S CONCEPTION of how National Bureau of Standards infrasonic system in Washington can detect tornadoes spawning in Oklahoma-Kansas "twister" country.

- **Page from electronics**—For the past ten years the NBS has been developing microphones and recording systems for studying very low frequency sounds in the atmosphere. The agency says that its present system, in Washington, is "unusually reliable and flexible and is calibrated easily."

NBS scientists have designed band-pass filters that can be introduced into the amplifiers when the signal-to-noise ratio is to be changed. For example, earthquake waves are said to be studied best with a band-pass filter tuned to sounds having periods between 0.4 and 20 seconds.

The system is described as consisting of four microphones located at ground level, approximately in the same plane. To reduce the effects on the microphones of pressure fluctuations from local turbulent wind conditions, the scientists fitted each microphone with an antenna comprising a 300-meter length of pipe.

The microphones produce frequency-modulated voltages proportional to the incident sound pressures. These voltages are transmitted by telephone wires to a central location, where they are demodulated, amplified and recorded as ink-on-paper traces.

When a sound wave of sufficient magnitude is present, similar traces are produced on each of the four paper records. The direction of approach of the wave and the trace velocity are obtained by comparing the different times of appearance at the four microphones.

- **Sound of magnetic storms**—Particle streams from the sun interacting with the earth's magnetic field cause geomagnetic storms. Associated with these are waves in the low frequency range—periods greater than 20 seconds—having a velocity usually greater than the speed of sound, sometimes as high as three times as great. The waves usually come from the north and have pressures of roughly one to three dynes per square centimeter.

NBS scientists feel that the high degree of association of these waves with the larger magnetic storms is significant. The direction from which these waves arrive varies with the time of day. The direction changes from northeast to northwest between noontimes, and is approximately northerly at midnight.

By finding the origin of these sound waves and by measuring their propogation constants, NBS expects to learn more about the structure of the upper atmosphere.

In the wide view, the emerging science of infrasonics may not only be useful for listening to the sounds in our own atmosphere but also to those in the foreign atmospheres that space probes may soon be exploring. ⁂

Exploiting the Advantages of Vapo

Microcircuitry stands to profit in a big way from relative freedom of approach; how Motorola and Merck have developed techniques

by Charles D. LaFond

VAPOR DEPOSITION TECHNIQUES being developed so widely in industry are adding a new dimension to junction formation in solid-state devices.

The approach is not limited by diffusion laws—as is junction formation by diffusion, or by segregation laws—as is junction formation for alloying. Exploiting this advantage, scientists at Merck & Co. and Motorola Inc., among others, are finding many useful applications for germanium and silicon deposition in microcircuitry.

In its research laboratories at Rahway, N.J., Merck's Electronics Chemicals Division has devised methods of laying down single-crystal layers of silicon of varying type, resistivity and thickness. The resulting complex junction configurations may someday be used for fabrication of entire circuits by appropriate etching, sawing, plating, and lead attachment.

The complete microcircuit is an electronic subassembly having extremely high packing density. This is one reason for the concentrated effort to achieve production capability with such sophisticated components.

The other reason is the potential of magnitude increase in reliability.

MOTOROLA'S CHOICE

Several methods exist for vapor deposition of thin film semi-conductors. Motorola chose one that produced a product readily usable in practical fabrication of components. This method was described recently before the IRE Professional Group on Electronic Devices in Washington by G. V. Russell of Motorola's Semiconductor Products Div., Phoenix, Ariz.

To reduce germanium and silicon tetrachlorides on single-crystal substrates, commercial hydrogen is passed through a Deoxo catalytic unit, then through a bubbling bottle containing the tetrachloride.

The vapor pressure of the liquid is controlled so as to provide a definite partial pressure ratio of H_2 to $XC1_4$, Russell said. Hydrogen gas, saturated with tetrachloride vapor, is then transported into the quartz reaction tube. As a heterogeneous reaction takes place between the heated substrate surface and the reactant vapors, growth of the film commences.

Waste gases are carried off through an exit tube where the hydrogen is burned off and other gases are exhausted into a fume hood.

The entire gas handling apparatus has been constructed of quartz, according to Russell.

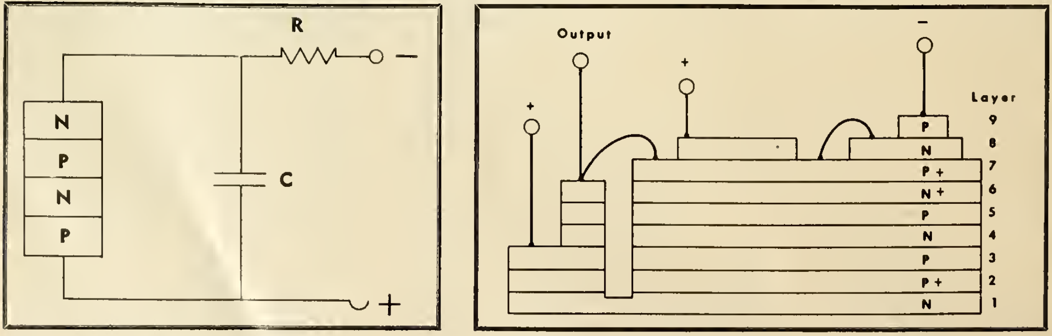
Substrates are laid down on a quartz boat supported on a graphite strip. The strip is heated by means of a 10-kw, 450-kc. r-f generator. Temperature of the substrates is measured with an optical pyrometer, and appropriate temperature corrections are applied to the observed readings.

All films of germanium and silicon were grown on single-crystal substrates of the parent material. The substrates were <111> oriented wafers cut from Czochralski grown crystals, lapped, mechanically polished, chemically etched, rinsed in deionized water, and blown dry in a stream of nitrogen.

- **The vital ratio**—A necessary condition for growth of continuous single-crystal films, Russell said, is that the partial pressure ratio of H_2 to $XC1_4$ be greater than 65:1. At such low supersaturations the growth rates tried in the past were from 0.01 to 2 microns/min. Substrate temperatures for germanium were from 700-850°C, for silicon 1050-1270°C. Single crystal films were obtained over this growth rate and temperature ranges. The choice of particular operating points is governed by the parameters required for the device being fabricated.

In the research described by Russell, only silicon devices with n substrates and n films, and germanium devices using p substrates and p films were used. However, other conductivity-type films have been grown at Motorola in the fabrication of silicon p^+ p, n^+ p, p^+ n, . . ., and germanium n^+ n, p^+ n, n^+ p, . . ., structures with con-

SIMPLE OSCILLATOR designed by Merck to demonstrate laminar structure for microcircuitry. Elements are a pnpn switch, back-biased diode (for capacitance), and a photodiode (for resistance).



A. Schemat for proposed relaxation oscillator circuit using layer structure.

B. Side view of plan for one-piece construction comprised of nine distinct layers.

Deposition

trolled resistivities and film thicknesses.

- **Etch-pit density**—The control of etch-pit density, said Russell, is governed principally by the cleanliness of the substrate surface. In the case of silicon, the removal of surface oxides is achieved readily during the period prior to growth by heating the substrate in a dry hydrogen atmosphere.

Surface oxides of germanium, if present at this stage, are not removed so easily, said the Motorola scientist. Thus the control of etch-pit density becomes a much greater problem with germanium than with silicon due to surface oxides acting as nucleants for disordered growth.

If correct cleaning procedures have been employed, the etch-pit density then is controlled predominantly by substrate temperature and degree of hydrogen supersaturation with the tetrachloride.

Excessive supersaturation, which results in too high a growth rate, will lead to polycrystalline film deposits in the extreme and down the line from high etch-pit density to what might be called the "intrinsic etch-pit density" (i.e., that of the substrate). At this stage the etch-pit density is strictly a result of direct copying from the substrate.

Studies of etch-pit densities have been made by Motorola using numerous etchants. The etchant giving best results, according to Russell, is a mixture of potassium ferricyanide, potassium hydroxide, and de-ionized water.

EVAPORATION PRODUCTION techniques yield pairs of gold and aluminum stripes on a 0.025-in.-square germanium wafer for mesa transistors at Motorola's Semiconductor Products Division in Phoenix. When the wafer is cut, each pair of stripes will become one transistor.

Film thicknesses were measured by delineating the change in resistivity between the substrate and the film; pulse-plating was used to delineate this change.

MERCK'S APPROACH

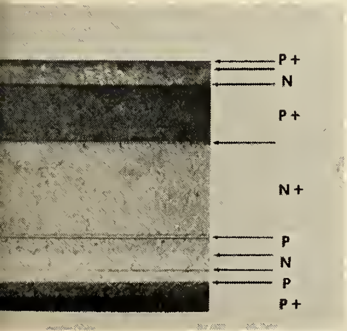
The Merck process is similar to that employed at Motorola, although much of the company's recent work has involved the introduction of controlled concentrations of impurity atoms during the crystalline growth of silicon single layers.

Merck's research has centered on the addition of volatile acceptor or donor impurity precursors during the growth process. The goal, of course, is formation of electrically active regions bounded by junctions of varying layer thicknesses, carrier concentrations, and junction profiles.

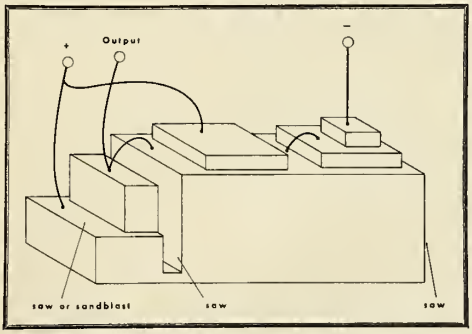
Reactions temperatures from 700-1300°C at growth rates from 0.25 to 5.33 microns/min. have been employed successfully.

Merck researchers also believe the substrate surface to be a variable of great importance in the growth process. But the substrate itself can be in many forms: filaments, rods, slabs, or sheets.

- **Orientation**—One early objective of Merck's studies was the effect of substrate orientation on single-crystal



C. *Etched specimen (magnified 100X) reveals deposited layers.*



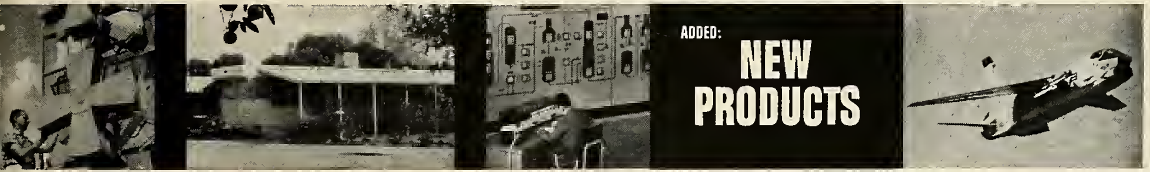
D. *Perspective view shows isolation of various junctions, lead attachments and terminals.*

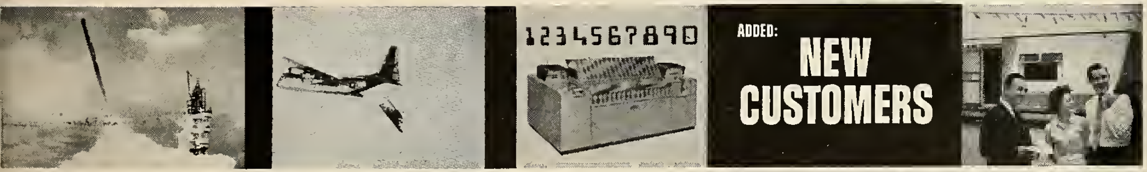
E. *Final specimen from which device properties were measured.*

NEW NAME.

CHANCE VOUGHT CORPORATION

The name used to be Chance Vought Aircraft, and it fit the company perfectly. No other name is more closely associated with aviation's growing years and great hours. Vought aircraft . . . a parade of over 40 different models . . . have served the U. S. continuously since 1919. Now, with the Crusader fighter helping to maintain the Free World's border watch, and with a newly developed all-weather version enroute to join the 700 Crusaders already delivered, aviation remains a vital interest at Vought. But today, Chance Vought has expanded beyond its traditional field into other market areas both military and industrial • The Aeronautics Division, which supplies the new all-weather Crusader to the Navy and is at work on other aircraft and missile projects, is also headquarters for a company-wide anti-submarine effort • The Astronautics Division — deep into studies for manned space flight — is prime vehicle contractor for the NASA Scout and a key contractor on the Air Force Blue Scout Junior, both research rockets • An aggressive Electronics Division supplies components and systems to major U. S. defense and research programs • Vought Range Systems is a world-wide service organization with space-tracking, range instrumentation and many other responsibilities • Vought Research Center feeds basic knowledge to all divisions • A subsidiary — Vought Industries, Inc. — is the nation's leading producer of mobile homes • Another subsidiary — Information Systems, Inc. — produces industrial automation and process control equipment • National Data Processing Corporation, in which Chance Vought owns a majority interest, specializes in business data processing equipment particularly in the banking field • Now, under Chance Vought Corporation, these diverse activities are associated in name as well as in skills and resources to serve both old and new customers better.





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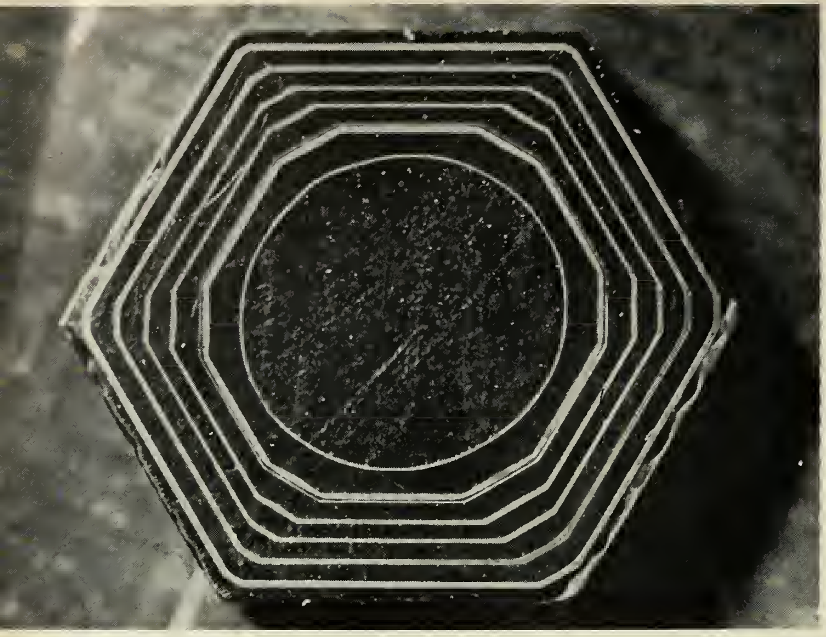


CROSS-SECTION of a <111> oriented silicon crystal, grown by vapor deposition at Merck & Co. with alternating p and n layers.

growth. This centered on an attempt to obtain single crystals with growth planes having maximum surface free of imperfections. From the observations made during this study, researchers found that:

(1) Substrate crystallographic orientation had a pronounced effect on the relative preservation of single crystallinity during the growth process.

(2) It was not concluded, however, that under different growth conditions one could not propagate equally well on all orientations.

(3) Under the growth conditions used in the experiments, the crytallographic planes that continued growth in single-crystal form were the $(\bar{3}21)$, (111), $(\bar{2}11)$, and $(1\bar{1}0)$ planes. The susceptibility to disoriented growth increased from left to right.

The substrate orientation that produced the highest yield of usable single crystal areas was the [111] oriented substrate. This orientation was used predominantly in the Merck study of the formation of electrically active layers and junctions.

• **Even growth**—The next step investigated was the introduction of impurity atoms to form controlled electrically active regions while continuing a contiguous single-crystal growth.

Experiments showed that boron trichloride for p-type doping was conveniently handled, easily controlled, and caused no adverse effect on the single-crystal growth of silicon—even with concentrations giving resistivities as low as 0.004 ohm-cm.

The n-type doping was accomplished satisfactorily with halides of either arsenic or phosphorous of known concentrations.

EMERGING TECHNOLOGY

Both companies have reached the point in process development where products are now being marketed.

Motorola epitaxial mesa transistors —germanium and silicon—were recently put on the market. More will be marketed soon, a company spokesman says, as production capabilities and reliabilities of new items equal those now available.

Merck is now supplying two-layer junction configurations in wafer form to other manufacturers of epitaxial transistors. And it has prepared and distributed sample quantities of more complex solid-state configurations.

Both companies have long stressed their belief in the application of vapor deposition techniques for future microcircuitry. Their research has shown that crystal growth from the vapor phase can provide devices comparable to those produced by conventional alloying and diffusion techniques—but without the limitations accompanying those methods.

Above all, today's techniques are laying the foundation for a whole new technology of complex multilayered subsystems for truly microminiaturized and ultra-reliable electronic systems. ⁑

Memory Aid

Librascope Device is Big Computer Advance

A SILICON DISK giving a computer a permanent memory capacity of 70,000 bits of information per cubic inch has been developed by the Librascope Div. of General Precision, Inc.

It provides a solid-state, non-rotating, permanent program storage, is capable of complete automatic production with selection and switching circuits, and has high radiation resistance and wide temperature limits.

The new device was incorporated in a proposal made recently to a government agency, said Robert R. Williamson, Librascope's director of military sales. The firm specified delivery in from 18 months to two years.

Librascope is a major producer of computers for fire control and space vehicle guidance systems. Its AN/ASN 24 is likely to be the first digital computer in space for lunar and interplanetary exploration as a part of the guidance for NASA's Project *Centaur.*

Charles Foodim, the firm's Aerospace Branch projects director, described the potentials of the silicon device in terms of the magnetic drum component of *Centaur's* computer. That has a six by six-inch drum with a 50,000-bit capacity.

JPL has for some time stressed its need of a computer for guidance purposes that has no moving parts. A major reduction in drum size is viewed as a step toward that. To develop a minimum size component for the temporary memory requirement, Librascope is working on a drum using air as a bearing surface for its spinning shaft.

Temporarily named "Silicon Permanent Array Memory," the unit is now in the pre-production testing and development stage.

• **Degree of serendipity**—The material was developed during a long-range research program not particularly aimed at this specific result, Williamson said. The device was conceived at P. B. Stokes of Librascope's Applied Research Department, directed by Wayne Blackburn, who with Dr. Herman Graffe also headed this phase of research.

Displaying a sample disk .008 inch thick and one inch in diameter, Williamson said its construction required depositing pure silicon layer by layer with a molecular beam. "We almost have to deposit each atom of silicon exactly where it should be," he said. Masking the layers to deposit discrete concentrations of magnetic material without hazy edges to impair separation of "bits" also proved a problem. ⁑

First Details of Red Rocket Shots

by Bernard Poirier

INFORMATION JUST RELEASED by COSPAR shows that Russia in the first half of 1960 launched 27 rockets in a series of high-altitude experiments from a research ship in the Pacific; tests that just as easily could have been of a military nature.

Disclosure of these tests is contained in an announcement from The Hague, Netherlands, listing a total of 73 Soviet rocket experiments during the first half of this year. Details were released by the Secretariat of the Committee on Space Research.

This international organization bases its data on official information supplied by the Soviets. An analysis of its statistics reveals that the launchings originated from land and naval platforms which are identified by COSPAR as:

–"Heiss Island, Franz Josef Land, 80° 37′N, 58° 03′E."

–"From the expedition vessel Voyeikov in the Pacific."

–"From the expedition vessel Shokalsky in the Black Sea."

–"Medium latitudes of the European part of the U.S.S.R."

(Photographs of the Black Sea rocket tests have been circulating in Europe and in America since July but until now no adequate information on the actual experiments had been available).

Franz Josef Land, which is about 1400 miles northeast of Sweden, has been a favorite research preserve of the Soviet Academy of Sciences since the area's discovery in 1873 by the Payer-Weyprecht Expedition. Meteorological bases were established at Tikhaya Bay (1929) and at Teplitz Bay (1932).

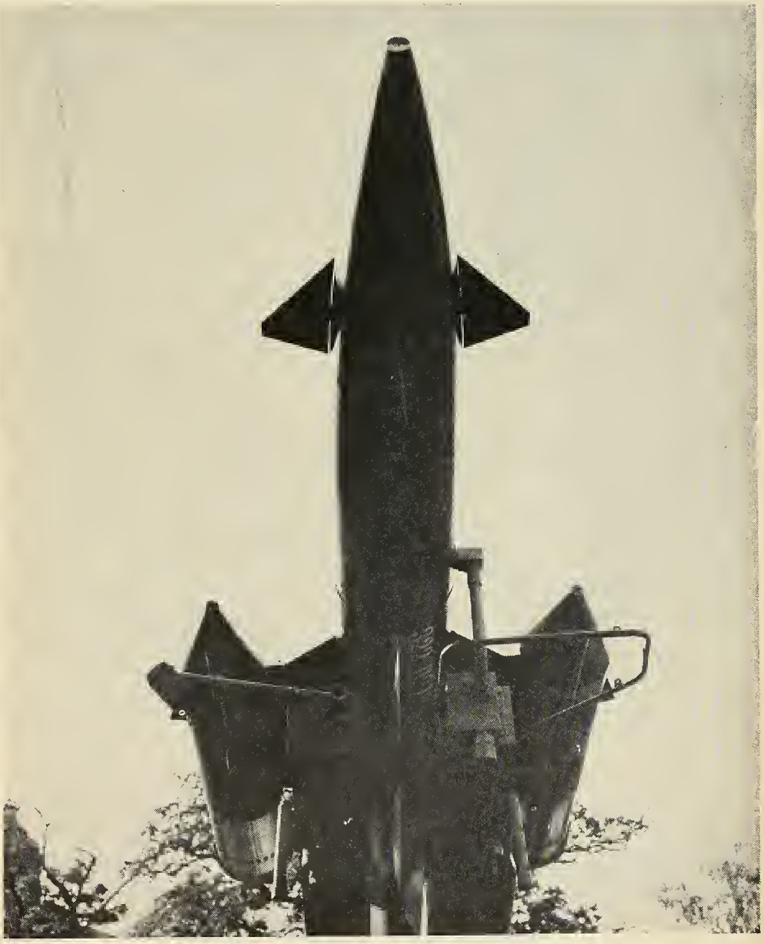
The identification of Heiss Island as a rocket site is the first official admission by Russia that the spot is used for that purpose. During the first three months of 1960 a series of 24 rockets were fired. Each launching was at midnight.

• **Reds provide test data**—The Russians claim to have measured the distribution of air temperature in this Arctic area and the stratospheric pressure. Instrumentation included electric resistance thermometers and therman and membrane manometers. It is assumed, however, that some of the tests measured electron density in the atmosphere in connection with the strong aurorae famous throughout the area from Sweden to Franz Josef Land, and that there also were experiments on magnetic field changes.

The Swedish Committee on Space Research is planning similar experiments in addition to special measurements of the strong absorption of radiowaves at high altitudes, which in this area of the earth start only a few hours after a strong solar flare.

The remaining Heiss Island shots were less frequent; there were only three in April, three in May and the last on June 9 for an overall total of 31. From April 19 on, the firings took place at 3 A.M.

Meanwhile, in the Pacific, scientists aboard the Voyeikov launched a rocket almost daily between Jan. 17 and Feb. 13. Double launchings occurred on Jan. 28 and 30 and Feb. 5 and 13. Most were fired between 10 P.M. and 11 P.M.; two were launched in late afternoon. Significantly, this ship was firing rockets daily at the time the Russians lobbed their first big missile



Swedish Test Missile

ROBOT 322, a Swedish-built experimental surface-to-air missile, is equipped with two RR 2 ramjet engines and one solid booster motor. Designed by the Guided Weapons Bureau, it is being used to test the ramjets and measure equipment.

soviet affairs

by Dr. Albert Parry

The science of rocketry changes so rapidly

that rocket officers in the Soviet armed forces should keep on learning new things all the time. So says the leading editorial in *Krasnaya Zvezda,* organ of the USSR's Defense Ministry, for Nov. 24. Similar exhortations appeared in that newspaper on Oct. 18 and Nov. 12 and 29, but the Nov. 24 editorial is the most explicit and urgent.

Entitled "The Engineer-Rocketeer Is a Fighter for Things New," it calls on the officers of the Red rocket detachments to work incessantly to improve their technical knowledge through "participation in military-scientific work, in inventiveness, and in the rationalization" of the devices and methods used in the Soviet rocket service. The article praises a certain Comrade Grebenyuk, who "has within a recent period put into practice nearly 80 suggestions" to improve his unit's rocket performance.

But there are also laggards

in Red rocket units, and these are castigated by *Krasnaya Zvezda.* The case of an officer named Turovsky is cited: "Having graduated from his institution of higher learning, he depended on his past knowledge, and gave little thought to his further training. The result was that the young specialist soon found himself behind in many respects. Now he is not only unable to give his men a service lecture fruitfully, but even fails to guide them in their technical work. What sort of authority is such a specialist to his men?"

Some Russian rocket officers flatly refuse

to train their soldiers, says *Krasnaya Zvezda,* and "lock themselves into the shell of purely technical tasks." The editorial quotes them as saying, in effect: "Our job is looking after the equipment, while the education and training of soldiers is the worry of other commanders." They particularly refuse "to develop the political awareness" of their men—that is, to lecture them on the virtues of the Communist Party. But more and more often a rocket engineer in a Soviet military unit is that unit's top commander. As such he cannot leave the Party assignment to others; he himself must prove constantly his "active participation in the Party's political work" in the USSR's armed forces.

The number of engineers and technicians is growing

in the Soviet armed forces, the editorial notes. As early as January, 1959, the proportion of engineers and technicians among commanding personnel in the USSR's military service had tripled since the end of World War II. By November, 1960, "the wide introduction of the most complex rocket technology increased this ratio yet higher," and the process is continuing.

One evidence of this is the stepped-up frequency of articles in *Krasnaya Zvezda* and other Soviet military publications, directly addressed to rocket troops. The Soviet leadership is clearly courting its military rocket officers—yet keeping a wary and stern eye on them, too. The Kremlin is anxious to have them both well trained and politically reliable.

Missiles and Rockets publishes fifty-one times a year. Readers are reminded that there will be no issue on December 26.

Season's Greetings—The Editors

into the Soviet impact area set aside in the South Pacific.

This may be more than coincidental. At least seven Pacific shots preceded Heiss Island shots by local time, but on the basis of corrected time most were within an hour or so of the other. In at least one instance, they may have been fired simultaneously—although separated by thousands of miles. Moreover, a meteorological rocket was fired at 3 A.M. local time from Heiss Island the day *Sputnik IV* was launched into orbit.

• **Worldwide sites planned**—The purposes and instrumentation of the Pacific and Black Sea tests are the same as those listed by the Russians for their Arctic experiments. The Russians do not provide the coordinates pinpointing their naval launchings.

(It is interesting to note that on the occassion of Khrushchev's Indonesian tour, the Red leader requested permission from that country to establish a Soviet research station on Amboina Island in the Bana Sea. It was inferred that the site would be used to support meteorological studies.)

Only five shots are admitted as being fired from the Shokalsky in the Black Sea, two on June 9 and three on June 10. Launching times are given as:

June 9 07h. 20m.
June 9 18h. 55m.
June 10 07h. 00m.
June 10 10h. 00m.
June 10 23h. 00m.

As long as three months ago, there were published reports asserting that Western radar had tracked these Black Sea shots and that the peak altitude reached by some was 20 miles and by others, 125 miles.

Photographs of some of the rockets used in the Shokalsky launchings show a nose cone configuration, which suggests the Russians also experimented in re-entry body problems.

The "medium latitude" shots from a site in European USSR follow the pattern established for those previously described with the exception of the fourth in the series of 10. The series started on May 26 and extended through June 30 with double headers on the 22nd, 29th and 30th.

Data for the fourth experiment, carried out at 3:42 P.M. on June 15, provides the most interesting details. This rocket carried a UHF radio-interferometer to measure the concentration of free electrons in the atmosphere and a radio frequency mass spectrometer to determine the ion and neutral composition of the atmosphere.

The payload was apparently quite heavy. It included cameras to photograph cloud systems, other instruments to measure the "electric field" along the rocket shell's surface, and infrared radiation instruments for earth surface studies and ionized upper-atmosphere cloud studies. Apparatus was also carried aloft for ultraviolet registration spectrograph measurements, as well as pressure and air density studies.

- **Aerospace biometric studies**—The payload was detached at 137.2 miles and the Soviets admit, in passing, that "medical and biological experiments were conducted simultaneously with geophysical studies." No further details were provided.

These experiments could have taken place in Poland. What the Russians call European USSR could mean the westward extension of the Russian border or an area in a satellite country. However, according to the Polish Academy of Sciences in Warsaw, 13 meteorological sites have been established in Poland.

Many of the sites were built to support Russian earth measurement studies essential for rocket military strategy. Examples are the Borowiec site sponsored by the Pozáan Astronomical Center. The Poles identify it as an astronomical station constructed at a latitude common with a station located at the Russian missile site near Irkutsk. Another coordinating station is situated along the 107° E Meridian in Vietnam and sponsored by the Polish Academy of Sciences.

Moreover, Polish research rockets of the *RM* series had been able to reach similar altitudes with instrumented payloads during the International Geophysical Year and were reportedly launched near Serco, about 20 miles north of Warsaw. Two meteorological stations are located closeby—at Legionowo and Barowa Gora. A third is in Warsaw itself. ⁂

Fellowships Offered by Guggenheim Foundation

Eighteen fellowships for graduate study in rockets, jet propulsion, space flight, and flight structures are being offered by the Daniel and Florence Guggenheim Foundation.

The fellowships provide tuition and stipends ranging from $1500 to $2000 depending on the level of advancement of the student. They are to be used at the Guggenheim Jet Propulsion Centers at Princeton University and California Institute of Technology and at the Institute of Flight Structures at Columbia University.

Applications are due March 1, 1961. Only residents of the United States or Canada who have outstanding technological ability and leadership qualities and intend to make a career in rockets, jet propulsion, flight structures or astronautics are eligible.

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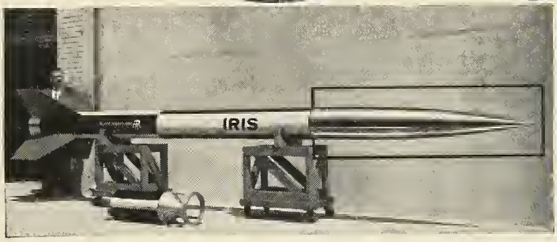

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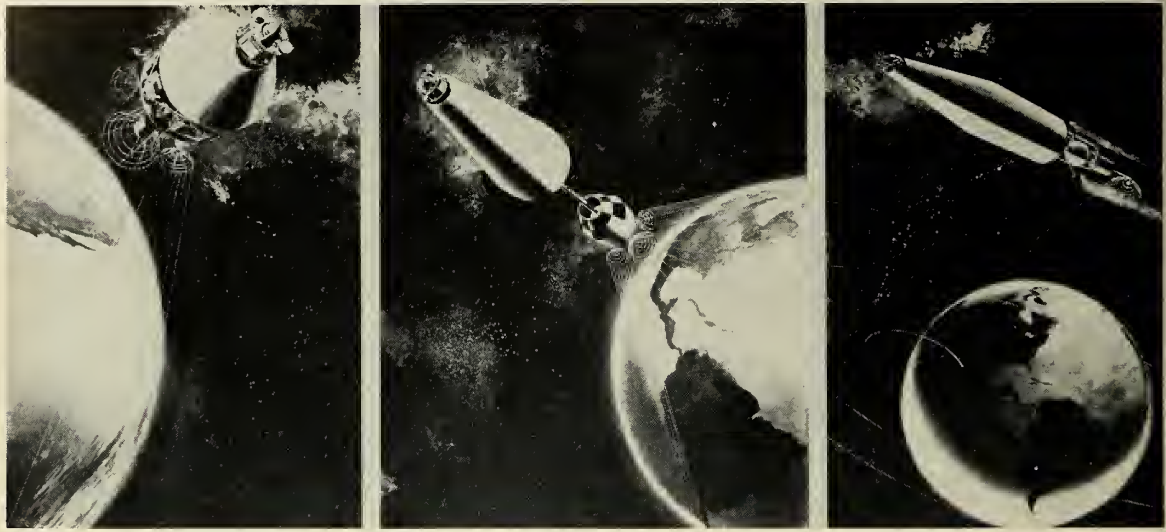


LEFT—*Satellite power supply, SNAP 10 (0.3 KW), available in two years.* **CENTER**—*SNAP 2 (3 KW) and SNAP 8 (35 KW) units available 1963-5 for 24-hour communications satellite.* **RIGHT**—*Nuclear system (1967) to power electrically-propelled vehicle.*

THE FIRST ESTIMATE of the cost of a global television system powered by nuclear energy, is $30-50 million. The figure, arrived at by a key Atomic Energy Commission official, is far lower than the cost of comparable systems powered by conventional means.

The nuclear-powered system could be ready by the mid-1960's. Its price includes the cost of launch vehicles as well as of three "stationary" satellites needed for the TV coverage.

Lt. Col. G. M. Anderson (USAF) said in San Francisco last week that 10 or 15 video channels could be telecast if the 35- or 70-kilowatt versions of SNAP 8 were combined with the *Atlas-Agena B* or the *Atlas-Centaur* space vehicles in a 24-hour orbit. Anderson is AEC's Chief of Systems for Nuclear Auxiliary Power (SNAP).

Home television receivers could be adapted to the global system by adding to each set a simple UHF converter and a six-sq.-ft. mesh-type antenna directed toward the stationary satellite. Estimated cost to the citizen is under $50.

Anderson stated that the 3-kilowatt SNAP 2 is able to furnish enough power for one or two video channels covering the entire United States. He added that SNAP 8 at 35 kilowatts could furnish five to ten channels over the United States, or one or possibly two channels over the hemisphere. This capability would be doubled if the 70-kilowatt version of SNAP 8 were used.

- **One two-hundredth the cost**—Suppose a 4500-lb. *Agena-B* satellite were placed in a 300-mile orbit. Then to spiral the satellite out to a stationary orbit—22,600 miles altitude over the equator—would take about three weeks if a 35-kilowatt SNAP 8 were powering the electric propulsion system.

The weights called out by Anderson for the satellite are 1500 pounds for the SNAP 8 unit, 300 pounds for the electric propulsion system, and probably 1500 of the remaining 2700 pounds in orbit for the communications system payload.

Assuming that the satellite located over the United States would power five to ten channels simultaneously for a year, Anderson derives a cost of approximately $300 per channel-hour. He says that this figure compares drastically with current transcontinental broadcast costs which run in the neighborhood of $60,000 per channel-hour.

"Even further reductions in the cost of a channel-hour would be realized when the *Atlas-Centaur system* becomes available; for the ITVB (International Television Broadcasting) system will then have at its disposal 70 kilowatts and a 2000-pound payload for the communications equipment," he says.

The SNAP 2 system is designed to generate 3 kilowatts of useful electrical power continuously for one year (see M/R, Aug. 22, p. 39). A prototype of the reactor for the system, called the SNAP Experimental Reactor (SER), was built by Atomics International Div., North American Aviation, and put into full-power operation in November, 1959.

The second SNAP power reactor, called the SNAP Development Reactor (SDR), is scheduled for startup next month. The results of SER operations brought changes in fuel composition, number and size of fuel rods, and reflector design—all of which led to a 20% weight reduction in SER.

The SDR will operate the first complete version of the power conversion system. All components in this series of tests will be designed for flight. The first flight tests of the SNAP-2 system are scheduled for early 1964.

The SNAP 8 power reactor is a larger version of SNAP 2; however, the reactor will produce 35 kilowatts with one power conversion unit and 70 kilowatts with two power conversion units coupled to the same reactor.

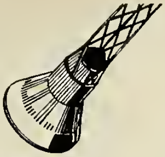
NASA says SNAP 8 will be used not only for long-range, long-lived communications from lunar and interplanetary missions but also for powering early electric propulsion devices.

The first SNAP 8 experimental reactor will go critical early in 1962. Flight tests will be several years later. ⁂

NASA program-highlights

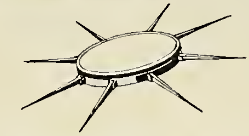
NEXT DECADE IN SPACE

Year 4 to 14 of the Space Age

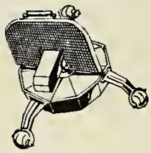


Project Mercury—U. S.'s first manned satellite.

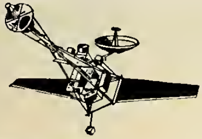
Project Surveyor—First soft landing on moon. Conduct observations from stationary position.



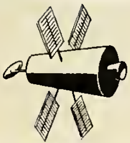
Project Prospector—Soft landing on moon and exploration of area within 50 miles of landing point.



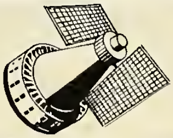
Solar Observatory—350 lb. Large flywheel and extended arms rotate to stabilize. Under construction.



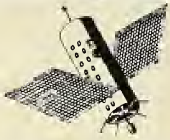
Project Mariner—600 to 1200 lbs. First U. S. Planetary missions to Venus and Mars. Modified craft for hard landings on moon.



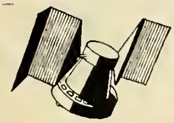
Project Voyager—Orbit Mars and Venus and eject instrumented capsule for atmospheric entry and perhaps landing.



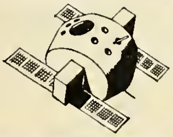
Nimbus—600 to 700 lb. meteorological satellite series. Stabilization system will keep cameras pointed earthward.



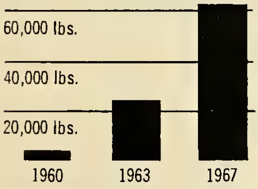
Orbiting Geophysical Observatory—1000 lb. geophysical research satellite designed for a near earth circular polar orbit or an inclined highly elliptical orbit.



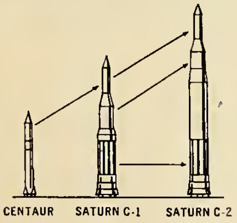
Project Aeros—24-hour stationary weather satellite. Launched in equatorial orbit. Three satellites could permit continuous observation of most of earth's surface.



Orbiting Astronomical Observatory—Standardized, 3500 lb. satellite, for several experiments with different scientific sensors and specialized devices.



Anticipated Growth of NASA Spacecraft in terms of weight of individual near earth satellites.



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NASA Marshall Space Flight Center • Huntsville, Alabama

NASA Wallops Station • Wallops Island, Virginia

National Aeronautics and Space Administration NASA be the *Rover* nuclear rocket. Many in industry believe the time is ripe for vehicle development concurrent with engine R&D, scheduled to begin with the award of a contract in the spring.

Major space contracts to be awarded in 1961 include R&D for the *Apollo* three-man spacecraft, the 800,000-lb.-thrust S-II *Saturn* stage, the *Surveyor* lunar soft-landing spacecraft and, if not awarded before the end of 1960, the standardized Orbiting Geophysical Observatory *(OGO)* satellites:

NASA will begin procurement action on what may be its biggest contract of all—the production job on *Saturn* boosters. Only the first 10 vehicles, during the R&D phase, will be produced at NASA's Huntsville, Ala., facility.

- **Toward manned flight**—Competitive six-month studies of the *Apollo* spacecraft are in progress at Convair, General Electric's Missile and Space Vehicle Division and The Martin Co. NASA is expected to choose one of them to begin R&D during the summer. The job will take about three years. Manned flights are expected to begin when *Saturn* vehicle reliability proves adequate.

The big *Saturn* stage will be developed for the four-stage C-2 *Saturn*, which will be the second version to fly. The first *Saturn*, designated C-1, will have three stages. The big new stage will be inserted between the first and second stages of the C-1. The four-stage vehicle is to be operational in the 1966-7 time period.

Competitive studies of *Surveyor*, an unmanned craft to be boosted by the *Centaur* launch vehicle, are in progress at Space Technology Laboratories, McDonnell Aircraft, North American's Missile Division and Hughes Aircraft. The R&D contractor will be chosen early in the year. First flight is expected in 1963.

If the new administration decides to speed the civilian space program, the chances are it will ask for more money for *Mercury* and *Saturn*, in addition to the nuclear vehicle development.

To fill the gap in lunar exploration between last week's scheduled *Atlas-Able* and the 1962 *Ranger* shots, some are proposing that one or more *Atlas-Delta* vehicles be obtained for 1961 moon attempts.

Depending on the results of a multi-agency study now under way, funds may also be requested for establishing an operational weather satellite system,

Major Missile/Space Developments During 1960

Manned Space Flight

Russia launched three 10,000-lb. prototype spacecraft, two of them carrying dogs and other life specimens May 15, Aug. 19 and Dec. 1. One craft recovered from orbit with dogs alive Aug. 21.

U.S. Air Force launched two black mice to lower edge of Van Allen belt, at altitude of 600 miles or more Oct. 14, recovered them unharmed in Atlas nose cone.

Mercury development fell many months behind schedule as result of failures in booster and booster-capsule mating systems and extreme caution of capsule designers attempting to attain high reliability. Controversy arose over program's future.

Unmanned Space Flight

First recovery of an object ejected from an orbiting satellite (USAF's Discoverer XIII)—Aug. 11.

First recovery from orbit of a capsule containing life forms (Russia's Sputnik V)—Aug. 20.

Successful launching of 18 satellites and one space probe—15 satellites and a space probe by the U.S. and three satellites by Russia.

First launching of two satellites with one launch vehicle (U.S. Navy's Transit II-A and Greb)—June 22.

Military Applications

U.S.S. George Washington, first Polaris submarine, went on station under the ocean surface within 1200 miles of Soviet targets—about Nov. 15.

First complete Atlas squadrons become operational at Vandenberg AFB, Calif., early in the year and Warren AFB, Wyo., in August.

First successful launchings of Transit navigational satellites—April 13 and June 22.

First successful launching of Courier delayed repeater communication satellite—Oct. 4.

U.S. decided to proceed with B-70 Mach 3 missile-launching bomber.

Civilian Applications

Tiros I and II proved feasibility of TV transmissions of cloud-cover pictures to earth from a satellite so as to improve weather forecasting accuracy; other weather satellite research speeded; U.S. Weather Bureau was assigned primary responsibility for use of operational weather satellite data.

Echo I, Courier I and moon bounce demonstrated use of satellites for passive and delayed active repeater communications techniques; NASA Administrator T. Keith Glennan invited U.S. industry to team with government in developing commercial satellite techniques; AT&T requested FCC channel assignments so it might launch a communications satellite.

Space Sciences

Solar flares emerged as major radiation hazard of manned space flight, exceeding even that of Van Allen belt, leading to speculation major manned missions may have to be scheduled only in time of solar quiet.

NASA gave Grumman and Westinghouse contracts to develop orbiting astronomical observatory—Oct. 10.

Pioneer V tracked and telemetered for 108 days, to a distance of 22.46 million miles—March 11 to June 26.

International

Britain cancelled Blue Streak; series of mergers occurred in British missile/space industry.

Ten nations formed committee for promoting European space research cooperation. Several nations accelerate sounding rocket programs.

NATO requirement for a solid-propellant IRBM stirred competition between land version of Polaris and uprated Pershing; proposal for independent NATO nuclear striking force sparked controversy.

Industry

Douglas Aircraft Co. position improved with victory in competition for Saturn S-II and Navy Missileer contracts and establishment of Astropower Inc., a subsidiary for long-range propulsion research.

Convair vice president Thomas G. Lanphier was forced to resign following his blunt public attacks on President Eisenhower's defense policies.

Air Force formed non-profit Aerospace Corp. July 1 to replace Space Technology Laboratories; STL entered industry competition for contracts.

Lockheed Aircraft Corp. acquired half-interest in Grand Central Rocket Co.

Propulsion

New Soviet launch vehicle, capable of orbiting more than 10,000 lbs., passed two series of flight tests, achieved operational status.

Trend to solids accelerated in the U.S. as Polaris became operational, Scout reached midpoint in vehicle development program and Minuteman neared first flight. Air Force and NASA authorized design studies of multimillion-lb.-thrust boosters.

First series of Saturn static tests proved feasibility of liquid engine clustering.

Air Force ordered development of storable-liquid Titan II.

NASA, following successful completion of Kiwi-A reactor tests, decided to begin R&D of Rover nuclear engine.

First restart in space achieved by Able-Star in Transit IB launch April 13. Restartable Agena B fired successfully for first time in Discoverer XVII Nov. 12.

Materials

Filament-wound plastic motor cases achieved complete acceptance; metal pressure vessels show continued improvement.

Pyrolitic graphite emerged as a high-

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which would use *Tiros*-type spacecraft.

There will be moves to increase the rate of investigation of the problems of orbital rendezvous. And development of the *Nova* all-chemical launch vehicle will be pushed as the logical successor to *Saturn*.

- **Picking space chief**—Probably the most newsworthy development of the year will be the impact of the new administration on America's space program. President-elect Kennedy, with Cabinet selection cleared away, can be expected to get down to work soon on selection of a NASA administrator.

Although some have proposed that Kennedy retain the present incumbent, T. Keith Glennan, most observers doubt that he will do so. Democrats familiar with the new administration's thinking agree with Glennan supporters that the administrator was about as effective as could reasonably be expected under the circumstances. They note, for example, that Glennan refused to accept a Budget Bureau figure of about $650 million for the 1961 NASA budget and eventually obtained $915 million.

Nevertheless, Democrats feel that Glennan has become publicly identified with a go-slow space policy because of the necessity of making speeches and other public statements in support of the Eisenhower program.

Space advisers to the new administration want, above all, a NASA administrator who will be the nation's No. 1 salesman of space exploration, something Glennan has been unable to be under Eisenhower.

What other qualities should a NASA administrator have? Here are the views of Abe M. Zarem, president of Electro-Optical Systems Inc. and a director of the American Rocket Society:

"He should be a missionary—an evangelist, with a keen sense of some sort of national rendezvous with destiny and how his job relates to it . . .

"He should be an effective manager of the space program. . . .

"He must be suave, a man of exceptional social manners, unusually winning ways—particularly for briefing Congress. . . .

"He must understand human beings—so as to keep in effective operation people of extremely diverse personalities. . . .

"He must understand the relationship between scientific knowledge and industrial might. . . .

"He must know generals and admirals, to maintain good relations with the military services. . . .

"He must know that spaghetti bowl, the Pentagon, how it works and how to get around it. . . .

"He must understand the workings of the Budget Bureau."

Zarem, who has been mentioned himself for the post, said he knows at least 10 people in the United States who fill the bill. He declined to name any names but said one is a college president, another heads a foundation and a third is a general. ⌘

---

temperature material in sizes and shapes once thought impossible.

Beryllium and molybdenum fabrication improved rapidly, leading to growing use in operational systems.

Technology of columbium and vanadium-based alloys improved to point where they are being considered for operational use.

GSE Electronics

Side-looking high-resolution radar developed and demonstrated by Texas Instruments.

Ruby optical masers (lasers) demonstrated by Hughes and Bell Labs.

Low-noise receiving system developed, with traveling-wave maser and largest parabolic horn antenna by Bell Labs.

First commercial 2200 mc equipment built by several companies.

Digital system use increases with spread of Digilock, Telebit and PCM.

GSE Facilities

Mistram, new GE super-accurate tracking system, started at Cape Canaveral.

Industry, government speeded construction of large space simulation chambers.

Construction began on 330-ft. Saturn gantry and launch pad at Cape Canaveral.

Field transporter, erector, launcher for Army's Pershing passed series of tests.

Air Force Minuteman train prototypes demonstrated.

Navy authorized feasibility study of Autec, Atlantic underwater test and evaluation center.

Antisubmarine Warfare

Navy began development of hydrofoil vessels to outpace nuclear missile-bearing submarines. Air-cushion skim craft tested.

Asroc underwater missile unveiled.

Navy completed Project Artemis study of ideas for setting up an ASW warning net, perhaps similar to Air Force DEW line.

Missile Master Completed

The Army announced successful completion of the Missile Master network of electronics centers coordinating air defense of the nation's major industrial and population centers.

The last of the system's centers was dedicated at Los Angeles last Wednesday. Previously completed were centers in the areas of Washington, Baltimore, Seattle, Boston, New York, Buffalo, Detroit, Pittsburgh, Philadelphia and Chicago. The Martin Co. is prime contractor and program manager.

Tory II-A Test Near

(Continued from Page 16)

tural behavior of the core design in a ramjet application; study of the aerodynamic behavior of the core/air heat exchange system; study of the reactor neutronic behavior and acquisition of experience in reactor operation on the program.

Initial tests will aim at intermediate objectives using fixed power, temperature and airflow rates, gradually building up to full power and temperatures. As in any test program, instrumentation is extensive. Thrust, however, is not a consideration in the Tory II-A-1 tests, and project personnel say it is not being measured.

They estimate, however, that thrust for such a system would be about 5000 to 10,000 lbs.

Original design parameters such as the determination of amounts of fissionable material needed to sustain a chain reaction were determined at LRL's Livermore facility in October. The reactor was brought to criticality there, and will be re-checked after installation in the test unit at the Nevada Test Site.

AEC pointed out the unconventional qualities of the Tory II-A reactor cores. Operating as a heat source, the reactor must have a very high power density with minimum weight and size. Half the reactor must be open for air flow. Temperature of the core reaches 2300°F, requiring exceptional core materials and nearby structural materials.

The reactor must also be able to withstand widely varying pressures and severe thermal stress caused by extreme temperature changes. Materials must operate in a high radiation flux, which in turn presents heat transfer problems.

- **Core materials**—The core assembly is constructed of about 100,000 beryllia tubular fuel elements, and measures about 30 in. in diameter by 45 in. long. Tubular tension rods running the length of the core act as structural support. The fuel elements are hexagonal rods measuring 4 in. long and ¼ in. across the flats. A center hole to allow for air passage is ⅕ in. in diameter. One half of the reactor core cross section is fuel elements and the other half is void for air passage.

Fuel elements are arranged so that each hole operates at about the same power and therefore imparts equal temperature rise to the airstream.

Designed as a heat exchanger, the reactor core has been divided into the small tubular sections described in order to minimize danger of breakage through thermal stress. Fuel elements

(Contnued on Next Page)

Sustaining chain reaction . . .

(Continued from Preceding Page)

fit together snugly within the structure.

Bundles of fuel elements are held together in a matrix of unfueled beryllium oxide links forming a hexagonal shape. These BeO links assist in preventing dislocations and displacements, and in assuring a uniform load distribution. They also take the bulk of the weight of the core, and are held together by 72 nickel alloy tubular tie rods running the length of the core, and located at the interstices of the BeO matrices.

A molybdenum base plate at the rear of the reactor holds the tie rods leading from the front support structure. The tubular tie rods are water cooled.

Dr. Harry L. Reynolds of LRL pointed out reasons for the strong support structure in the reactor. "Air pressure drops from 300 psi to about 200 psi after passing through the reactor," he said, "and we have a total of 100,000 pounds of pressure being exerted on the face of the reactor. To hold the thing together, we must have a support structure to withstand this push at 2300°F and in a high radiation field."

The thrust of the air pressure drop in the core is carried downstream to the rear of the reactor, where it is picked up by the base plate and transmitted to the tie rods.

The entire core and tie rod assembly is supported within a cylindrical metal shroud attached to the relatively cool forward end of the main air duct.

• **Control system design**—Basically, the 30 in. diameter of the core is not sufficient to sustain a nuclear chain reaction, due to the escape of neutrons. Therefore, a method of reflecting neutrons and preventing their escape has made the system workable. A graphite reflector surrounds the core, and some of the elements within the core are unfueld, also to act as reflectors.

Controls for the reactor are presently located in this graphite reflector, but future models will have the controls directly in the core. The neutronics of the core for flyable versions will presumably be such that no reflector, or at least a smaller one, will be included.

The beryllia tubes in the first 10 inches of the core length and those in the last two inches at the rear end contain no uranium fuel. These are reflectors for the neutrons.

The main reflector is an annular shield of graphite, two feet thick and supported outside the air duct.

The control system, within the shield, is in several forms. Each of the eight sections contains a control element, either a vane or cylinder, of graphite, rotatable by a control actuator. Near the periphery in a sector of each cylinder are a number of stainless steel tubes loaded with boron. Rotating the cylinder changes the position of the boron tubes and thereby controls the reactor by governing the degree of reflectivity of the shield.

A high degree of reflectivity keeps neutrons from escaping, and thereby sustains a chain reaction; allowing neutrons to escape through the vanes, or cylinders, reduces the power level a corresponding amount.

Another facet of the control system is four sliding boron steel rods placed about the inner portion of the reflector, closer to the core than the main control rods. Each of the 12 control elements in the shield is moved by a separate hydraulic actuator, set up so that normally the eight rotating cylinders move in unison.

In event of an emergency, the reactor can be "scrammed" by rapid actuation of the control elements to immediately stop the reaction within the core. The four rapid rods in the shield can be completely scrammed in ⅕ second, while the other four rods take ½ second.

• **Air supply**—The air supply at the test site is from a bottle system with a capacity of 120,000 lbs. of air at 3600 psia. Held in a system of large steel pipes, the supply will allow a full power run on the reactor unit for about 90 seconds.

Before entering the reactor, the air is heated in a stored-energy unit consisting of a large bank of steel tubes stacked in a cell, and preheated by an oil-fired furnace. The steel raises the temperature of the air to about 1060°F at the reactor inlet, thus simulating the inlet temperature of a Mach 3 ramjet.

After passing through the reactor, the air is directed upward through a 38° nozzle angle. The throat of the nozzle, where air velocity is Mach 1, holds pressure against the exit face of the reactor core.

By producing the sonic speed exhaust stream, the nozzle assists in raising the air to sufficient altitude so that radioactive residue is not deposited on the ground immediately behind the test area.

• **Environmental considerations** — Problems with reactors under extremely high stresses are expected to be ironed out with units such as the Tory II-A series, among them are aerodynamic and acoustic factors.

AEC and LRL do not want air flow within the test unit to reach above Mach 1, due to negation of nozzle advantages by sonic shock waves within the engine. If air were to reach to great velocity in the engine, its dwell time in the reactor would be too short for it to acquire heat. Shock waves would choke the nozzle and render it ineffective. Additionally, there is the possibility that the shock waves could damage the fuel elements in the core.

Another consideration in the design is that of acoustic damage to fuel elements and other components.

The test setup at the Nevada Test Site is an attempt to simulate conditions for a vehicle moving at Mach 3, ambient air pressure 14 psi and ambient air temperature of 100°F.

• **Safety**—A carefully laid out safety program is part of the Pluto project, due to implications of having a nuclear ramjet flying around the world dropping fallout on everything. Officials say exposure to the exhaust would be about 40 REM for nearby personnel, and would drop to a fraction of that for people standing directly under the exhaust if the vehicle passed over at 1000 feet altitude.

According to Brig. Gen. Branch, thirty flights of an *SLAM* vehicle with a nuclear ramjet would release 1/260 of the strontium 90 resulting from one 20 kiloton nuclear explosion.

• **Pluto facilities**—Cost of facilities for the Pluto program has thus far amounted to a total of $28,300,000. Installations at the Nevada Test Site amount to about $10 million of this, and those facilities at the Livermore laboratory total about $3,100,000.

Congress has also authorized additional funds for Tory C facilities, mainly in the air supply system.

• **Contractors**—Numerous companies are handling major portions of the Pluto program, under direction of Lawrence Radiation Laboratory. The Marquardt Corp. is under AF contract to develop non-nuclear components of the ramjet system.

Other companies include Atomics International Division of North American, basic materials research and development; General Electric, fuel element fabrication; ACF Industries, test vehicles; National Carbon Co., graphite reflector; Brush Beryllium, beryllium oxide and BeO parts; Coors Porcelain Co., fuel elements; Bendix Corp., special components.

In addition to the work on Pluto reactors, Air Force has awarded, through its Wright Air Development Division, two contracts to Chance Vought for navigation and radar systems for vehicles such as *SLAM*. One contract is for a "Fingerprint" navigation system, and the other for a terrain-avoidance radar to allow a vehicle to operate at a constant 1000-foot altitude, or other specified level.

Aircraft and Astronautics Application Panel, Nat'l Academy of Sciences

(See story of panel's report, p. 12)

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Soft Radiation Detector

A portable survey meter capable of detecting extremely low levels of radiation, particularly designed for use around radar and microwave installations and X-ray laboratories, is being marketed by The Victoreen Instrument Co.

At the heart of the unit's transistorized circuitry, is a new type of vibrating capacitor. The instrument will operate over 100 hours on one set of flashlight "D" batteries.

The Victoreen 440 will detect and measure radiation of less than 1 milliroentgen an hour by picking up currents generated as the radiation enters an air ionization chamber through a very thin "mylar window." It covers an energy range of 6.5 kev to 1.2 mev and its read-out dial can be set for one of five sensitivity ranges which encompass from zero to 300 milliroentgens per hour.

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Small Center Lapping Unit

J&S Tool Company, Inc. is marketing a center lapping machine, made especially for lapping centers in small parts. The unit makes it possible to lap standard as well as recessed center holes from 1/16 in. diameter and larger, at a highly increased rate of production.

Designed to lap both centers simultaneously in pieces up to 8 in. long, machine has two opposing precision high-speed spindles which are individually driven by 10,000 r.p.m. motors with reversible switches.

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Subcarrier Discriminator

A Subcarrier Discriminator for analog data systems, completely transistorized and designed for higher sensitivity, compactness, and versatility, is available from Data-Control Systems, Inc.

The Model GFD-3 Transistorized Subcarrier Discriminator, with its associated tuning units, filter networks, etc. saves space, requires less power and eliminates separate adjustment of each channel.

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ASW Cable

Boston Insulated Wire & Cable Co. is marketing cable which prevents the passage of water through from one compartment to another, even though the cable be severely damaged or cut on the seaward side of the bulkhead. Pressures on the exposed end will withstand 1000 pounds per square inch in conformance with hydrostatic test of MIL-C-915A, Amendment 8. Multi-conductor and coaxial constructions are available for all deep water applications.

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Digital Signal Simulator

An electronic digital signal simulator for PCM systems in the field or in the development laboratory is available from Telemetrics, Inc.

Designated the ESS-500, the Telemetrics' unit simulates the digital output of an airborne or ground multiplexer and digitizer for both calibration and checkout, presenting serial data.

Interchangeable coding modules which plug in flush with the front panel enable the ESS-500 to generate any type of code, including binary, bcd, excess 3, biquinary, hexidecimal, 1224.

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Phosphorescent Analyzer

An instrument capable of exciting, measuring, and recording phosphorescence of innumerbale compounds is available from American Instrument Co.

The instrument, the Aminco-Keirs Spectrophosphorimeter permits excitation of compounds and measurement of resulting phosphorescence throughout the ultraviolet and visible regions. An additional capability of the instrument is to quantitatively analyze phosphorescent compounds.

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Hypersonic Gas Meter

MHD Research, Inc. is producing a V-Meter for measuring the velocity of luminous hypersonic gas flows. The instrument incorporates a single, adjustable control that provides the operator with instantaneous and continuous direct readout of velocity over a range from 2,500 to 50,000 fps. The fast response of its optical transducer allows accurate measurement of time intervals to 2 microseconds.

Circle No. 231 on Subscriber Service Card.

Miniature Cryogenic System

A self-contained miniature cryogenic electronic cooling system is available from Air Products, Inc. The closed cycle system uses nitrogen to provide one watt of refrigeration at 80°K.

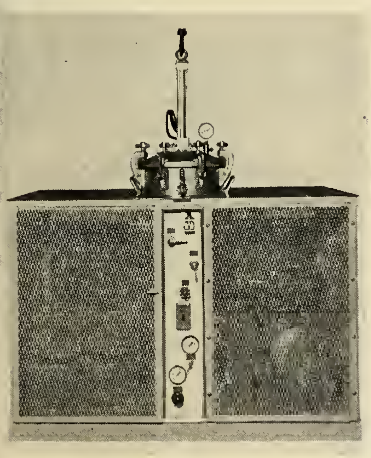
This system is unique in that no gas or liquid supply is required. Systems previously available have required bulky cylinders of gas or elaborate storage containers for a liquid supply. This 16-lb. system is designed to run continuously for 500 hours between maintenance periods.

Circle No. 232 on Subscriber Service Card.

Vacuum Impregnating Unit

The National Sinter-Seal Co. has available a method and a corollary unit for sealing powdered metal parts.

The Sinter-Seal process consists of a completely self-contained, low-cost impregnating unit which uses a specially formulated resin. After the technique of sealing was evolved, together with the resin, this unit was engineered specifically to implement the Sinter-Seal process.



The Sinter-Seal unit accommodates up to 5400 cubic inches per hour. The simple four step process is completed in 10 minutes or less. The clean operation of the unit ensures minimum waste of impregnant; automatic solenoid valves guarantee smooth positive operation.

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Bonded Transit Caser

Transit cases completely bonded together are available from Zero Manufacturing Co. The bonding eliminates welding and riveting.

Standard laminated aluminum panels are cut to size and assembled using standard hardware, corners, extrusions, fittings and an epoxy resin. The whole unit is then cured at room temperature.

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new literature

INSTRUMENT SUMMARY BROCHURE—A 20-page summary brochure designed for handy reference to their instrument line is available from the Instrument Division of Bourns, Inc. The brochure contains basic specifications on pressure transducers, position instruments, accelerometers and instrument/systems. Thirteen new instruments are introduced in this brochure including three new accelerometers, two new position instruments, two new pressure transducers plus a whole new field of instrument/systems.

Circle No. 200 on Subscriber Service Card.

FLAT GLASSES—Corning Glass Works has published a bulletin detailing the properties and characteristics of several flat glasses, covering both Pyrex brand and Vycor brand flat glass products. The bulletin gives charted information on physical properties, chemical durability and working pressures. It contains transmittance curves.

Circle No. 201 on Subscriber Service Card.

TRANSISTORIZED POWER SUPPLY—A 4-page illustrated brochure describing an ultra-high regulation transistorized D.C. power supply has been published by Krohn-Hite Corp. The brochure fully describes the instrument's unusual features and design innovations, and includes complete technical specifications and ordering information for all models of the Krohn-Hite transistorized power supply.

Circle No. 202 on Subscriber Service Card.

DIGITAL MEASURES—A special applications section is featured in the new 12-page, two-color bulletin available from Non-Linear Systems, Inc., on its Industrial Series digital measuring instruments. The section covers 17 uses of the NLS 481 digital voltmeter and the NLS 781 digital ohmmeter with individual photos and descriptive material. The booklet also includes a 2-page color spread on 481 digital voltmeter features, comparisons of the 481 digital voltmeter features.

Circle No. 203 on Subscriber Service Card.

O-SEAL VALVES—A complete line of O-Seal valves and fittings for 6000 psi liquid or gas service is described in Catalog 60 available from Combination Pump Valve Co. The valves are designed to operate at temperatures from -20°F. to 275°F. and are available in all standard piping sizes from ¼-in. to 2 in. The line includes globe, angle, needle, check and relief valves.

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If interested and qualified, please forward your resume to Mr. J. E. Goode, Assistant Chief Engineer, P. O. Box 748M, Fort Worth, Texas.

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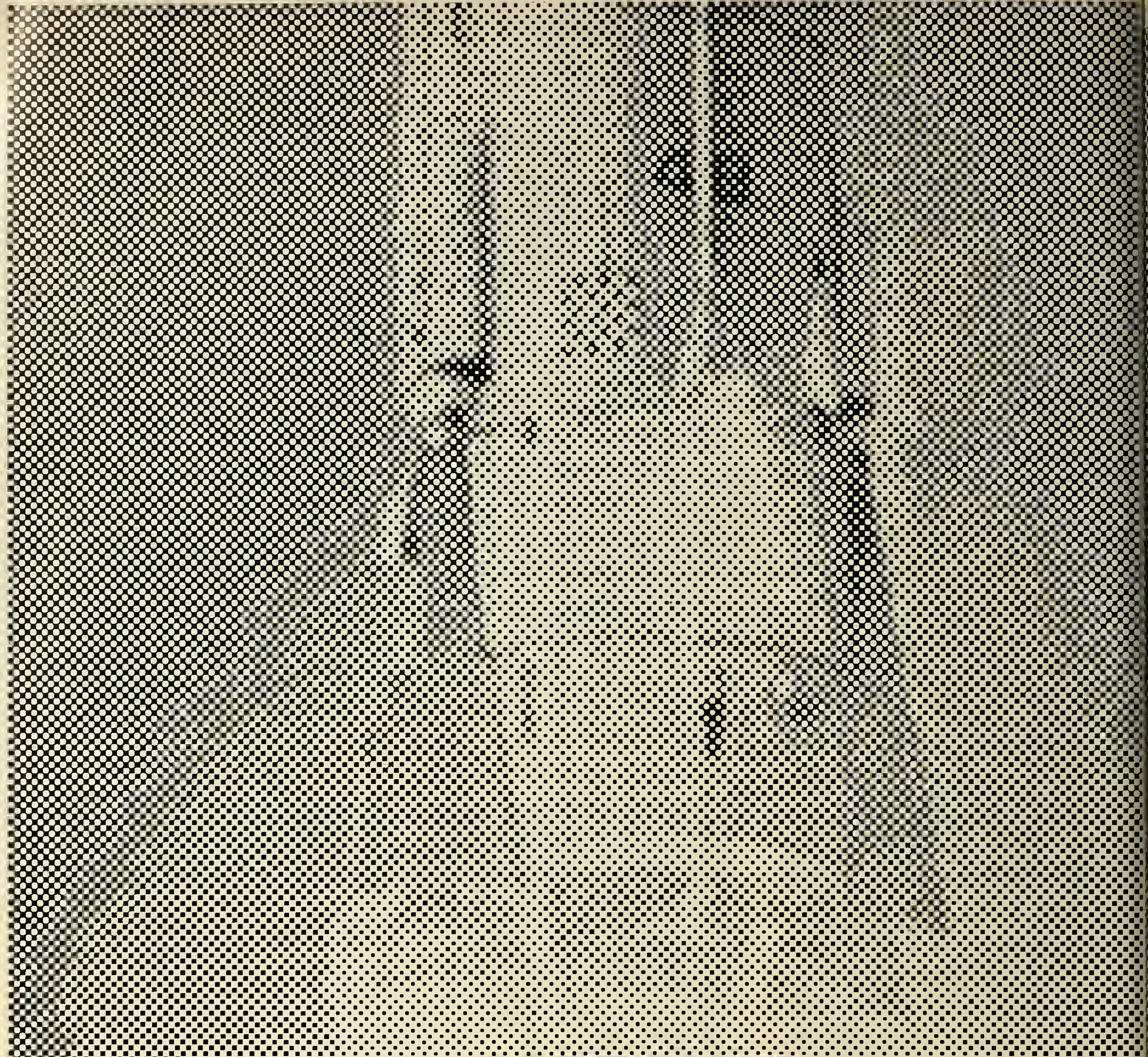
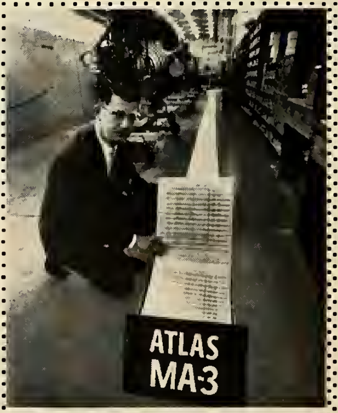
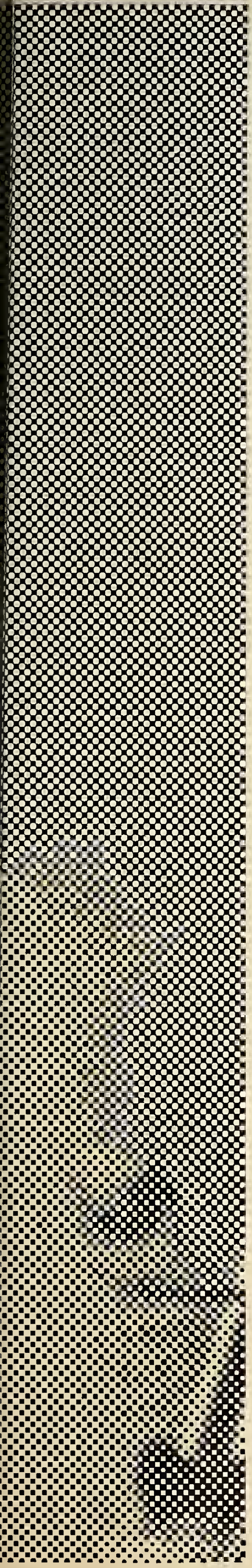




Computer-listed master catalog of engine parts reduces production lead time at Rocketdyne.



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Rocketdyne, the pioneer in rocket science, was first with power for America's long range ballistic missiles—first with power for outer space. In establishing this technological leadership, Rocketdyne developed new management concepts at every level of operation, from early design through final testing. The result is outstanding technical achievement at the lowest possible cost.

In data processing alone, advanced techniques are saving engineers hundreds of hours of experimentation and testing and have contributed to a 37 percent reduction in Atlas engine costs for the Air Force. An intracompany communications network links test stands and research laboratories in Missouri, Texas and California; gives management the daily status of every program—whether it's on schedule, what parts are in short supply, how the production line is performing.

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This diversification of effort in the interests of National Defense can be helpful to you. We recently opened a new laboratory and office in Encino, California, to provide closer liaison with the heart of the missile industry, and to bring our capabilities to bear directly where they are most needed.

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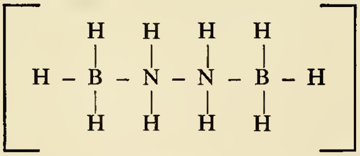

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It is a white, crystalline, free-flowing powder of uniform high purity.

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—contracts—

NAVY

Kaiser Engineers, Oakland, Calif., for preparation of construction plans and specifications for the new probe missile launch complex to be constructed at the Pacific Missile Range. Amount not disclosed.

$34,000,000—General Electric Co., Pittsfield, Mass., for design and fabrication of advanced fire control systems for *Polaris* firing submarines, designated Mark 84.

MISCELLANEOUS

$1,750,000—Ling-Temco Electronics, Inc.'s Temco Electronics & Missiles Co., for antisubmarine warfare weapon system work. Subcontract from Lockheed Aircraft Corp.

ARMY

$204,280,000—The Martin Co., Orlando, for *Pershing* missile system.

$27,770,000—J. A. Jones Construction Co., Nello L. Teer Co., and D. W. Winkelman, Charlotte, N.C., for construction of missile launch facilities, *Titan II*, Phase I, near Davis Monthan AFB.

$1,139,675—Thiokol Chemical Corp., Bristol, Pa., for *Pershing* motor parts.

$1,037,169—The Martin Co., Orlando, for components for the *Lacrosse*.

$1,000,000—General Bronze Corp., Garden City, N.Y., for metal shipping and storage containers for the *Hawk*. Subcontract from Raytheon Co.

$400,000—North American Aviation, Inc., Downey, Calif., for repair and overhaul of *GAM-77* parts and components.

AIR FORCE

Minneapolis Honeywell Regulator Co., prime contract for first-phase development of the inertial guidance system for the *Dyna-Soar* vehicle. Amount not disclosed.

$12,000,000—Stromberg Carlson Div. of General Dynamics Corp., Rochester, N.Y., for communications systems for *Titan* missile bases.

ARPA

Convair-Astronautics Div. of General Dynamics Corp., San Diego, for building three experimental satellite payloads to investigate deep space conditions. Amount not disclosed.

CLASSIFIED

THE UNIVERSITY OF SYDNEY

Applications are invited for an Associate Professorship and Lectureships/Senior Lectureships (2) and Lectureships (2) in Mechanical Engineering from graduates in Science or Engineering with strong research interests in any of the following: Analytical Methods in Applied Mechanics; Kinematics and Theory of Machines; Thermodynamics; Combustion; Fluid Mechanics; Control and Information Theory; Turbines and Rocket Propulsion; Elasticity and other branches of Engineering Science. The available facilities include access to the High Speed Computer SILLIAC. For further information write to the Registrar, University of Sydney, Sydney, Australia, with whom applications close on 31st January, 1961.

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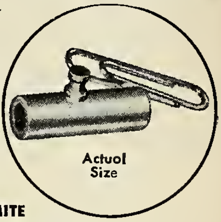

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The Solid Gold Moon Truck

THE FIRST POSITIVE STEP toward the creation of a nuclear-powered propulsion unit which would take a man to the moon and back was taken recently when NASA and the AEC asked American industry for proposals on the development of a nuclear rocket engine.

The purpose of the first nuclear rocket engine would be to power the third stage of an advanced *Saturn* vehicle and give it certain interplanetary capabilities it cannot accomplish with chemical fuels.

A bigger nuclear engine riding on a more powerful booster would provide the means of sending a man to the moon and back.

Harold B. Finger, manager of the AEC-NASA Nuclear Propulsion Office calls a moon vehicle the "Solid Gold Truck."

Finger is the man who invited the proposals and by so doing made the first move to get the U.S. nuclear space program off dead center. It has been resting there since it originated in 1954 as an idea of the von Neumann committee and was initiated by the Air Force as a study contract in 1955.

Six U.S. companies, some new and some old giants of the U.S. aerospace industry, are said to be preparing the proposals. The contract will probably be let in early 1961.

To an extent much greater than those not close to the program know, U.S. industry has accumulated a very solid and even reasonably extensive base for the nuclear rocket program, which would greatly magnify our capability of sending massive loads into space.

Pump, nozzle and reactor control technology is well advanced and in good depth. What remains now, as Finger points out, is development by logical stages—ground testing, flight testing, development of sufficiently large reactors and a continuing program of advanced systems.

It is with the fourth phase we concern ourselves here—the continuing program of advanced systems.

It will avail the U.S. space program little to push forward with the development of a nuclear space engine unless we *at the same time* start a concurrent program to develop the system which will contain the engine.

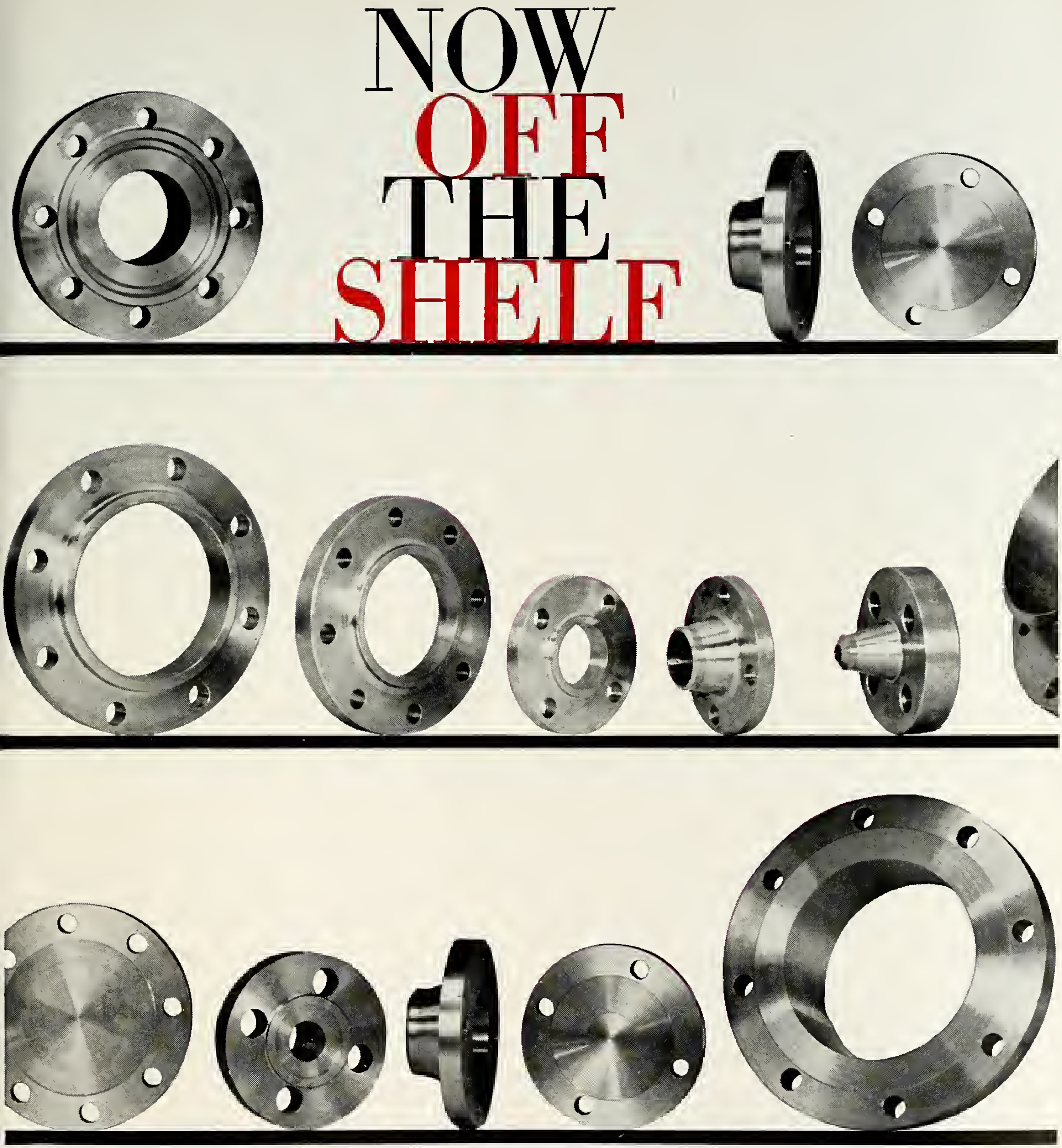
The concept of concurrency is simply a way of saving time. For the *Rover* rocket engine it would mean creation of a third-stage rocket case simultaneously with the development of *Rover*. It would mean solving some of the hundreds of problems connected with the enterprise at the same time instead of waiting until the engine is proven. It would mean, among other things, solving some knotty difficulties of hydrogen storage during flight, of the effect of radiation on materials and equipment.

TO QUOTE THE AEC-NASA Nuclear Propulsion Manager:

"The problems that face us in the development of vehicles to land the first man on the moon are the same as the ones that are faced by any other nation intent on landing men on the moon. The only differences that may arise in the accomplishment of such missions are related to the national determination to do the mission and to do the detailed engineering and technology that must be developed within the framework of the basic scientific tools; within the framework of the formulas that express natural scientific phenomena."

Solving the problems leading up to an eventual moon flight will, however, take time. It is this time which we can buy through the application of concurrency. Neither the cart nor the horse, in this case, can be placed ahead. They must be available simultaneously.

Clarke Newlon



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